

L. 21. e. 19.

THE  
CONSTRUCTION  
OF  
T I M B E R,  
From its EARLY GROWTH;  
EXPLAINED BY THE  
MICROSCOPE,  
AND PROVED FROM  
EXPERIMENTS,  
In a great VARIETY of KINDS:  
IN FIVE BOOKS.

On the PARTS of TREES; their VESSELS; and their ENCREASE by  
GROWTH: And on the different DISPOSITION of those PARTS in  
various KINDS; and the PARTICULARITIES in their VESSELS.

WITH FIGURES OF  
Their various APPEARANCES; of the INSTRUMENT for cutting them;  
and of the MICROSCOPE thro' which they were viewed.

---

By JOHN HILL, M. D.  
MEMBER of the IMPERIAL ACADEMY.

---

L O N D O N:

Printed for the AUTHOR;

And Sold by R. BALDWIN, in Pater-Noster-Row; J. RIDLEY, in St. James's-Street;  
J. NOURSE, T. BECKET, P. ELMESLY, J. CAMPBELL, in the Strand; and  
T. DAVIES, in Russel-Street, Covent-Garden.

M.DCC.LXX.



## INTRODUCTION.

**I**T is proposed to shew the Construction of Timber: the Number, Nature, and Offices of its several parts; and their various arrangements and proportions in the different kinds: To point out a way of judging from the structure of Trees the uses which they will best serve in the affairs of life; and of adding something to their strength.

The composition of the whole, the variations in the disposition, and the differences in the proportion of the several parts, are, in many of the species, so strange, and in some so very delicate, that to see them distinctly requires pieces of such an extreme thinness, and magnifying powers at once so great and so clear, that it were vain to lead men into an attempt of following the experiments, without first acquainting them with the machine by which the pieces were cut; and the Microscope thro' which they have been viewed.

The Cutting Engine is an invention of the ingenious Mr. Cummings. The two or three first were perfected under his own hand; and they are now made for general use by Mr. Ramsden.

### DESCRIPTION of an INSTRUMENT for cutting Transverse Slices of WOOD, for MICROSCOPICAL OBJECTS.

**A A.** Plate I. Fig. 1. represents *a cylinder of ivory*, three inches and a half long, PLATE and two inches in diameter; to the one end of which is fitted

I.

**B B.** *A plate of bell-metal*; the section of which, with the manner of fitting it to the ivory, may be seen in Fig. 2. in which the several parts are marked with the same letters as in Fig. 1.

**C.** is *a plate of brass*, fitted to the other end of the cylinder; through which and the ivory there pass two long screws, which take into the thick part of the bell-metal B B; so as to fix both plates strongly to the ivory; into which they are also indented, so as to prevent such shaking as might otherwise happen after swelling or shrinking.

**D D.** *The Cutter*; whose edge is a spiral, and the difference of whose longest and shortest radii is equal to the thickness of the largest piece of wood that the instrument will take in. The lowest side of this cutter must be ground extremely flat and true, in order that all the parts of its edge may be exactly in the same plane; and that the middle part of it may be applied closely to the flat circular plane left at the center of the plate B B, to preserve it in the proper direction when carried round by the handle.

All that part of the bell metal, which *the edge of the cutter traverses*, is turned so low as not to touch it, (see the Section:) the middle of the cutter is about; of an inch thick, and has in it a square hole that fits on the end of a steel axis P P, one end of which turns on a pivot in the Plate C, the other end in the plate B B. This end has a conical shoulder which fits into a hole of the same shape in the under side of the plate, as represented in the Section.

**e e.** *A piece of brass somewhat in the form of an index*, which is also put on the axis P P: this piece has a round hole in its center so large as to admit of its being turned into any position with regard to the cutter; and in order to keep it concentric thereto there is left on it a circular projection which fits into a cavity made in the lower side of the handle, where it fits on the axis. (See the Section.)

B

F. The

## INTRODUCTION.

PLATE F. *The handle*; which is so fitted on the axis PP, that it carries the cutter and the piece ee round with it.

G. *A Nut* that screws the handle on its axis, and keeps the cutter flat to the bell-metal BB, when carried round by the handle.

ooo—*Is a hole nearly in shape of the sector of circle*, pierced through that part of the bell-metal which the edge of the cutter traverses, and continued through the whole length of the ivory cylinder, truly parallel to its axis, and of an exact equal width throughout, till it terminates at the plate c.

H. represents the end of a piece of wood of which slices are to be cut, and which is put into the cavity ooo; into the angular part of which it is gently pressed by means of

K K. *Two brass screws*, which pass thro' the ivory into the cavity ooo, and are made to press on the wood h by means of

L. *A key* that fits into hollow squares made in the screws K K.

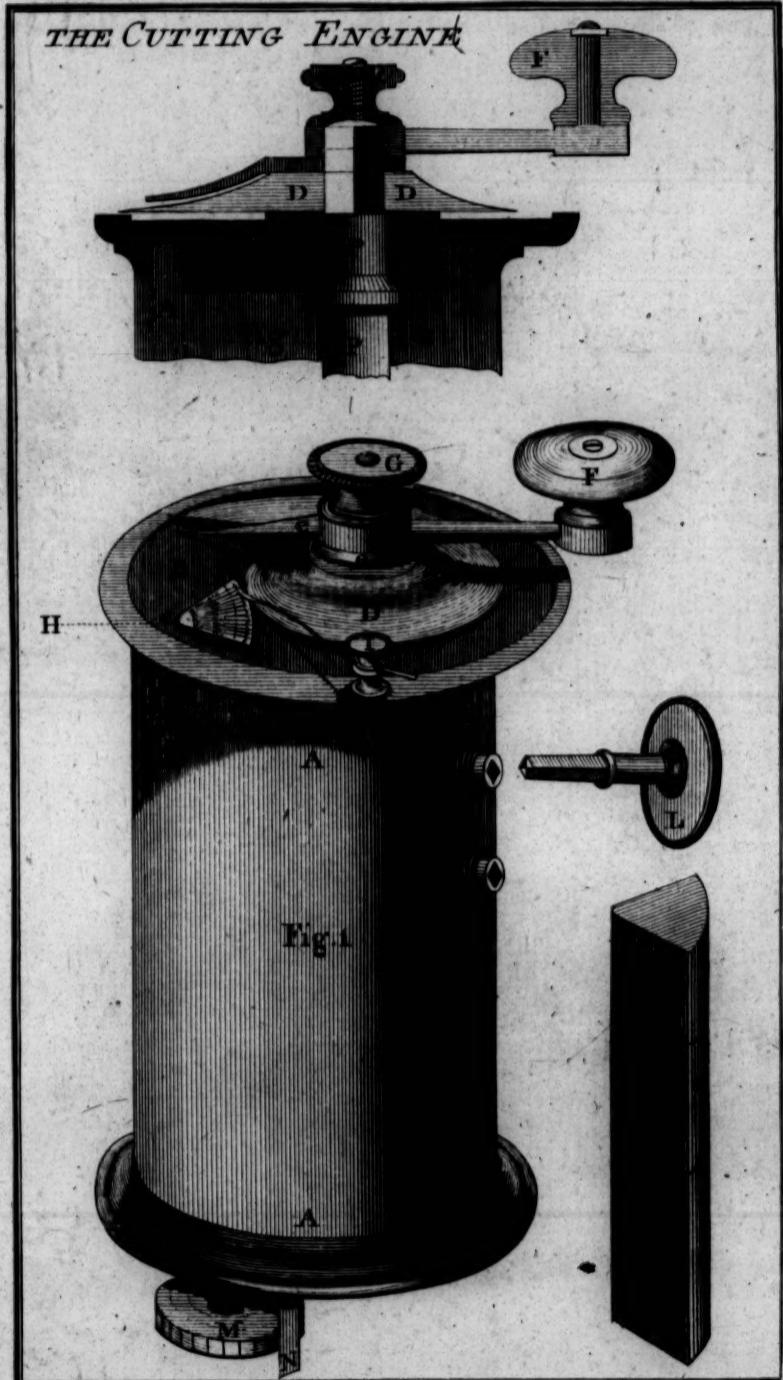
M. *A screw that passes thro' the brass plate C*, opposite the middle of the cavity ooo; and by means of which the wood h is raised to the cutter. This screw has forty threads to an inch, and its head being divided into twenty-five equal spaces, it is evident that the moving one of these divisions or spaces will make the screw advance and raise the wood h just one thousandth part of an inch.

N. *An index* that points the divisions on the head of the screw (M). The breadth of this index, from the one fiducial edge to the other, subtends a division and a half on the head of the screw; by which means half divisions as well as whole ones may be accurately shifted, and the 2000th, 1500th, 1000th, 750th, &c. parts of an inch truly estimated. To render the effect of this screw the more certain, its point is turned round so as to act very near the center, and a piece of ivory (see Fig. 3.) is carefully fitted into the cavity ooo, so as to move freely therein without any lateral shake, and to rest on the end of the screw M. This piece of ivory acting equally on every part of the under surface of the wood, will raise it towards the cutter with much more certainty than if the screw acted immediately on it. Several such pieces of ivory, of different lengths, (as represented by Fig. 3.) ought to be fitted to the instrument, so as readily to suit the length of any given piece of wood. One piece of the full length of Fig. 3. must have one end left rough from the file, that pieces of cork, agaric, the pith of wood, and such other soft substances may be cemented on it with sealing wax; in which case they can be cut into slices of a determinate thickness, as well as wood.

Now if a piece of wood, whether round or of the shape represented in the instrument at (b), and of whatever size, be put into the cavity ooo, and gently pressed into the angular part thereof by the screws K K, let it be raised towards the cutter by means of the screw M. If the handle be turned to the right, the edge of the cutter will advance on the wood, and cut off such part as lies above the plane in which the edge of the cutter moves; and when the upper surface of the wood is thus rendered flat, slices may be cut of any required thickness, according to the number of divisions that the screw M is made to advance. If the machine be made with due care, it will readily cut a thousand slices in an inch; and if the edge be good and very well set, slices may be cut that are no thicker than the 1500th or even the 2000th part of an inch: but this requires management, much depending on the force with which the screws K K pinch the wood.

It is not an easy matter to procure an edge sufficiently fine for the above purpose; but with the very best possible, thin slices have a tendency to curl up into rolls, so as to be unfit for the Microscope; to prevent which, a very slender spring is made to press gently on that extremity of the slice where the incision begins, so as to keep it flat to the cutter: when this spring is set to its proper position, it is fixed to it by the small finger-screw I. And lest the action of this spring should destroy the slice after it is wholly cut, and in passing over the extremity of the cutter, the piece ee (which turns with the cutter) is fixed by the nut G into such a position, that in passing under the spring it raises it, and relieves the slice at the very instant that the cutter has wholly done its office: and thus the slices are made to fall into spirits of wine, in which they are preserved for use.

Pl. I





## I N T R O D U C T I O N.

In some woods the pith shrinks so very fast that it is extremely difficult to keep it entire in slices that are thinner than 750 to an inch: to remove which imperfection an instrument, of the nature above described, was made to shift its own screw at every revolution of the handle, so that very little time was left for the pith to shrink; as a hundred slices could easily be cut in a minute, and the pith was as entire as the wood. This instrument had an index, which being set to the numbers 500, 750, 1000, made it cut so many slices to an inch. It performed extremely well, but was judged less fit for general use than that which has already been described, it being more complex, and liable to disorder, as well as more difficult to manage.

The composition of the MICROSCOPE (which was made, by direction of the Noble Person who is pleased to be the Patron of this Work, and its Author; by Mr. Adams, in Fleet-Street, Mathematical-Instrument-Maker to His Majesty) will be understood by the annexed figure. Plate II.

### A DESCRIPTION of the VARIABLE MICROSCOPE.

A B C, the body of the Microscope, contains two eye glasses at A, a third near B, and PLATE a fourth in the conical part B and C. The end C shews also one of the magnifiers screwed thereto. II.

Hence the body of this Microscope exceeds those hitherto made, which have only three glasses; by increasing the field of view, and the light; as well as affording an occasional opportunity of increasing the magnifying power of each particular object glass: which is performed by pulling up the part A E, and the outward tube A B: the first separates at A, the other at B.

Another advantage attending this instrument is, that any two of the magnifiers may be used at the same time; in this manner: screw the button *b* to the part *c* of the button *a*, and then screw both together into the body at C; the magnifier there represented being first removed.

There are seven of these magnifiers; two of which are shewn at *a* and *b*: also six silver specula, each having a magnifier adapted to the focus of its concavity; one of which is represented at *e*; these are to be screwed occasionally to the body at C. Every one of the seven buttons, *a b*, may also be used with any one of these specula, by screwing the lower part of the frustum of a cone, which is figured at *d*, upon the prominent screw on the silver speculum at *e*, and then screwing the part *c* of any button *b* into its upper end, and all together into the body at C.

*Note.* The glasses are marked 1, 2, 3, &c. and the least number is the greatest magnifier.

The body of the Microscope A B C is supported by an arm F, into which it may be put or taken out occasionally, and may be fastened by the screw *f*. This arm is fixed to the bar G G, which may be raised or depressed by turning the large ivory head I, (the screw at H being first discharged.) G G slides close to the upper part of the long bar K L, which last is firmly fixed at N and N to the tooth-wheel N O N; this wheel is supported by four scrobes whose extremities are connected to an horizontal circular plate *n*, which gives an horizontal motion to the wheel, the bar K L, and every other part of the Microscope which is connected thereto; the whole being supported upon the pillar M by the three feet P P P.

The annexed figure of the Microscope is delineated from its perpendicular position, being that which affords the best representation of its several parts; but there will be no difficulty to conceive, that on turning the key S the pinion that works in the teeth of the wheel N O N will give the bar K L, with the Microscope and all its appendages, any obliquity or inclination that may be required.

The stage, D D D, with a hole T in the middle, is designed to place objects on for observation; these being first fixed in an ivory slider, No. 1. or upon a slip of glass, No. 2. or they may be placed upon one of the round glasses which are fitted to the hole at T.

The

## INTRODUCTION.

PLATE. The concave mirror Q turns vertically on the extremities of the semicircle g, and II. horizontally in the cylinder b, by which means it may be directed so as to reflect the light thro' the center of the stage at T, and thence thro' the body of the Microscope to the eye at E.

The stage D D hath a conical pin which fits a hole in the slider W, in which it may be turned sideways, so as to examine any object too large for the field of view.

The scrole b R has also a conical pin fitted to a hole in the slider V.

By means of the slider W the stage D D may be readily set to its proper distance from the magnifier in the button at C, and then by turning the large ivory head I, the body of the Microscope may be brought to its distinct focus. If this be not thought quite sufficient, tighten the screw at H; and then by turning that at X it may be adjusted to the eye of any observer with the greatest precision, and by the help of the slider V a proper spot of light may be readily obtained.

No. 3. is a cylindrical tube, in which an inner tube k is forced upwards by a spring: its use is to receive an ivory slider No. 1. or a glass slider No. 2. the object being placed in the center of the hole at m, and the slider put between the plates b and i. The hollow at k is to receive a glass tube for confining a small water animal, to see the circulation of the blood.

If the animalcula in fluids are under consideration, or any very minute insect, it will sometimes be necessary to exclude part of the light which is reflected from the mirror Q by putting the cone No. 4. upon the bottom i of No. 3. it being first put into the stage at T.

The nippers, No. 5. are for confining any object, and are to be placed in one of the small holes near the extremities of the stage, or in the socket r, at the end of the chain of balls; No. 6. as the pointed nippers t, which hold an opaque object v. The stage D D being removed, and one of the silver specula screwed to the Microscope at C, the slider W brought near to the slider V, the stem x of the pillar belonging to the chain of balls being put into the hole at W, the balls may be readily managed to give a proper direction to the object v t, and the observer's back turned to the window, so that the reflection from the mirror of the sky behind or one side may fall upon the silver speculum, and thence be returned upon that part of the object t v which is to be examined.

No. 7. is a box containing spare tales, to supply the ivory sliders.

No. 8. is a double convex lens, to be used as a magnifier in the hand.

Lastly, Remove the body A B C, and put the stage D D into its place in the arm F; put the pin of No. 9. into the hole at z, in the top of the bar K L; place an object upon the stage; and any one of the magnifiers before described may be screwed into the end e of the sliding bar e g.

In this state of our variable instrument we have a single Microscope to which the above apparatus is applicable: three magnifiers are added, to be used only in this application.

There are likewise added to the apparatus, two glass planes broader than that of No. 2. and two others with hollows ground in them.

Also a few flat, round glasses, of different colours, which fit the hole T in the stage D D: and a watch glass, fitted to the same place, for observing the animalcula in fluids;

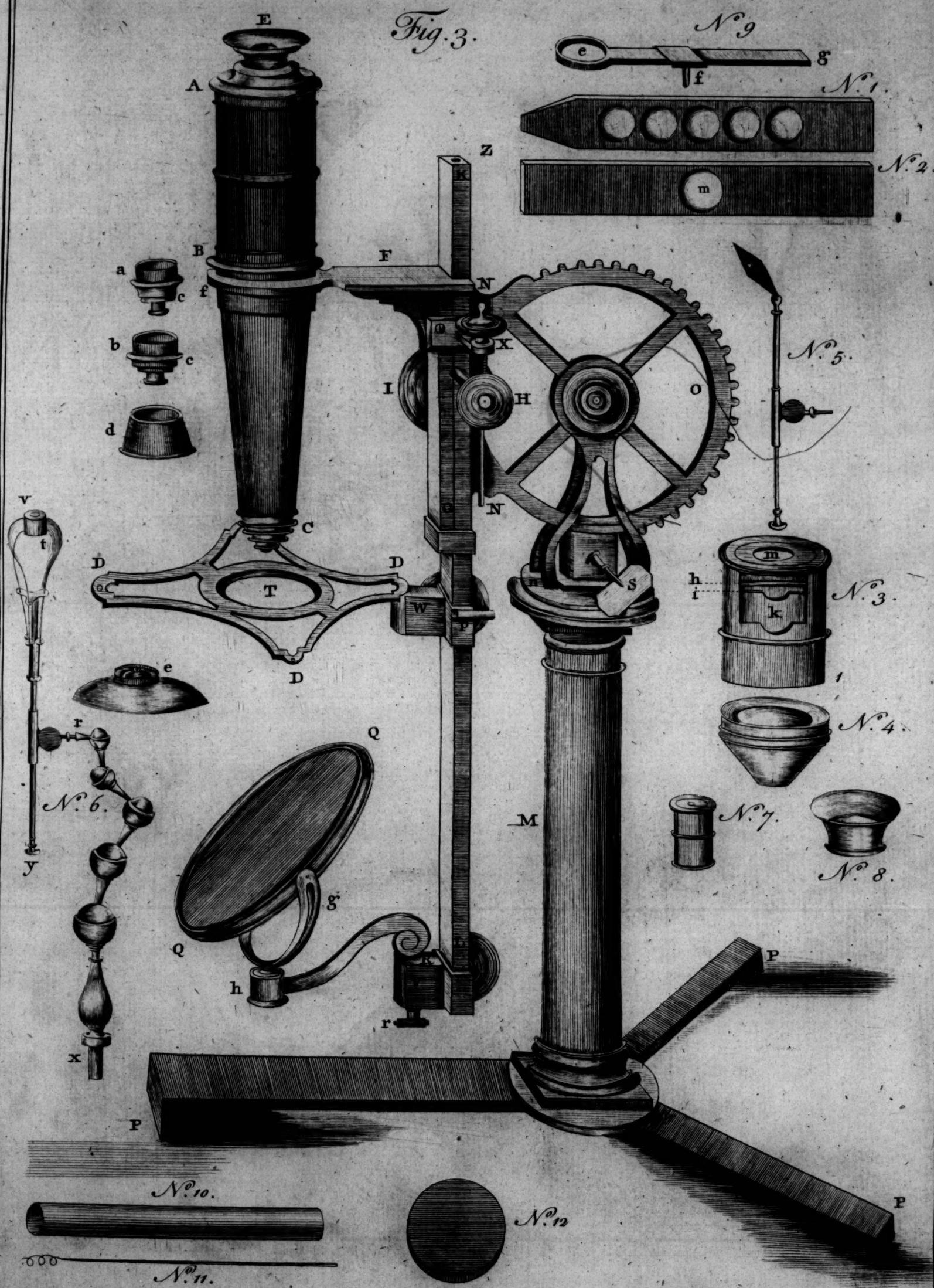
And a set of glass tubes.



## THE VARIABLE MICROSCOPE

By George Adams, N<sup>o</sup> 60, Fleet Street, LONDON.

Fig. 3.





T H E  
C O N S T R U C T I O N .  
O F  
T I M B E R  
EXPLAINED BY THE MICROSCOPE.

---

B O O K I.

Of the constituent Parts of T I M B E R.

---

C H A P. I.

Of the Number of Parts in T R E E S , and the Manner in which they are disposed.

**T**HE composition of Wood is best seen in a Shoot of two years and a half PLATE growth : and the most distinct and pleasing view of the several parts, as they III. lie together, is to be obtained by placing a very thin slice, cut transversely from such a Shoot, before the fifth glass of the reflecting Microscope.

Greater Powers, and another Apparatus, will be required for the examination of every part of this composition, separate ; but before we enter upon that enquiry, it is best to take this general view of all together.

The whole Slice consists of several concentric Circles, of different substance ; with vessels, also of different kinds, interspersed among them.

The Parts are these :

1. The RIND.
2. The BARK.
3. The BLEA.
4. The WOOD.
5. The CORONA, or CIRCLE OF PROPAGATION.
6. The PITH.

C

These

## THE CONSTRUCTION OF TIMBER

PLATE These lie immediately within, or under one another: and in, among, and between  
III. these, are disposed the Vessels, which feed the whole; and some of which contain the  
juices, that give the Tree its peculiar qualities, and virtues.

These Vessels are of five kinds:

- |   |                  |
|---|------------------|
| 1. The EXTERIOR<br>2. The INTERIOR<br>3. The INTIMATE<br>4. The SAP-VESSELS.<br>5. The CORONAL. | } JUICE-VESSELS. |
|---|------------------|

Of these, the first are placed between the Rind and Bark;  
The second, in the substance of the Bark;  
The third, in the substance of the Blea;  
The fourth, in the substance of the Wood;  
The fifth, in the Corona, or Circle of Propagation.

Besides these greater Vessels, the several parts themselves are vascular; but their Tubes are of another kind; and will be considered when we examine the construction of those several parts. Other Glasses will be required for this: they scarce appear in the present View; which is limited solely to the arrangement of the constituent parts together.

The tree in which these several circles lie in the happiest way for observation, is the Scarlet Oak of America. If a slice be cut from a two years and a half Shoot of this tree, in May; the parts and vessels just enumerated will be seen as they are represented in PLATE Plate III; and this with great distinctness and precision. Where this tree is not at hand, III. such a slice of the common English Oak will very well supply its place, the parts lying very nearly in the same manner.

*a* *a* represents the Rind, dry, and very thin.

*b* *b*, the exterior Juice-vessels. These are placed in round clusters; they are woody; and contain a thin, whitish, watery juice, of no taste.

*c* *c*, the Bark. This consists of a multitude of filmy bladders, ranged in circles, one behind another: they are elliptic, thin, and brownish; and they hold also a watery juice. They are connected together, and arise in these circles one behind another.

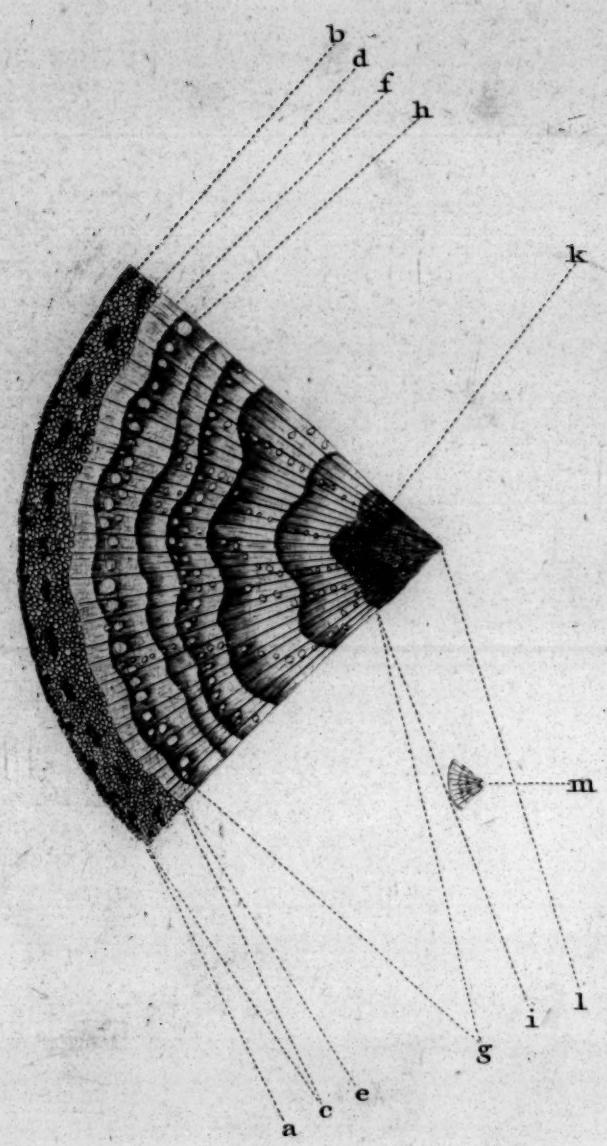
*d*, the interior Juice-vessels. These are arranged in oval clusters, a very considerable number of them together. They are of many times the diameter of the preceding: their coats are woody; and they contain a thick, gummy, brown juice, of an austere, styptic taste. This gives the virtue to the Oak Bark, as an astringent; and its quality, so useful in tanning animal hides.



*e* represents

OAK

Pl. 3





## EXPLAINED BY THE MICROSCOPE.

9

*e* represents the Blea. This consists of connected circles, which have, in so thin a piece, PLATE viewed perpendicularly, a great deal of the appearance of the bladders in the Bark; but III. they are in reality of a different nature, as we shall see, when each part is examined separately: these circles are indeed transverse sections of elliptic vessels, arranged closely side by side together. These are equal in their whole diameter to the bladders of the Bark; but their cavity is much less, because their sides are thick.

*f* shews the intimate, or most inward Juice-vessels of the Oak: they are somewhat larger in diameter than the constituent vessels of the Blea; and they stand singly, not in clusters, as the two former: they contain a thick and almost concreted brown juice, more austere than that in the vessels of the Bark: and it is from these the wood of the Oak possesses the same austere and astringent qualities with its Bark.

*g*. In the whole space from *g* 1 to *g* 2 we see the Wood. This is composed of five concentric circles, terminated by so many undulated lines. These are the several coats of Wood, added from season to season. It has been supposed that each circle is the growth of a year; but a careful attention to the encrease of wood has shewn me, beyond a doubt, that two such are formed each year; the one in Spring, the other soon after Midsummer. At each of these times the Branch shoots out in length; and whensoever that is done, the Shoot of the season before, gets an additional coat in thickness: I shall therefore be permitted to call these, instead of Year Circles, *Circles of the Seasons*. The Branch from which the present section was taken, having been of two years and a half growth, there are found in it five such circles.

The composition of the Wood is of vessels half obliterated, by the growth of their sides filling up their cavities inwardly; and swelling out in the same manner externally. The whole interstitial space being thus filled up, the very forms of them are by degrees lost.

At *b* are shewn the Sap-vessels of the Oak. Concerning which, there have been strange mistakes. But it is not my purpose to point out where others have erred; but plainly to lay down what I have seen, and what the objects themselves are ready to make plain to every one.

These vessels arise in the substance of the Wood, principally towards the outer edge of each circle. They are very large in the outermost coat; and smaller in the others: and there are also irregular ranges of them, running through the thicknesses of the circles, beside these principal ones of the outer course. They have solid, and firm coats; and they contain in Spring, and at Midsummer, a limpid liquor, like water, but with a slight acidity: at all other seasons of the year they appear empty, their sides only being moistened with the same acid liquor. Those who examined them at such seasons, thought them air-vessels; and in that opinion, formed a construction for them, which Nature does not avow.

*i* shews the Corona, or Circle of Propagation; a part of the utmost importance in the Vegetable Oeconomy; since from it arise the branches, and encrease of the tree: no Vegetable

## THE CONSTRUCTION OF TIMBER

PLATE getable is without it; nor have the figures of those, who have drawn the parts of Plants,  
III. failed to exhibit it, as a portion different from all others; yet, till this occasion, it never had  
a name. It is in the Oak an undulated circle; and the undulations of all the other circles  
take their rise from it. It contains distinctly two kinds of vessels; a larger, *k*, which are pale;  
and a smaller, which are browner; together with an intermediate matter: this is not  
vascular, but composed, as the bark, of filmy bladders. The larger order of vessels contain  
a somewhat acid juice; the smaller order, a very austere liquor; and the intermediate  
substance, pure water.

*l* represents the Pith. This takes the same undulated form in its outline as the Corona,  
which every way incloses it: its appearance is very pretty: it seems to consist of rings,  
with single, double, and intersecting outlines; but the reality is otherwise. The whole  
is a compages of little, hollow, white films, arranged, side by side, across the entire space,  
and having others of the same kind, and form, beneath them; through the whole length  
of the Shoot.

*m* shews the entire Slice in its natural bigness.

Such is the construction of a Shoot, and such the disposition of the several parts: we  
may now proceed to their separate examination.

## C H A P. II.

## The Manner of obtaining the PARTS of a SHOOT separate.

THE enquiry into the structure of each separate part of the Shoot, is a matter of  
much greater care and attention than the former: I will not say, of difficulty;  
for every thing yields to a determined mind: but time and application will be required.  
The method I have used is this:

In the beginning of April I take a quantity of young branches, from the Scarlet Oak,  
and other trees: these are first cut into lengths, of the growth of different seasons; and  
then part are left entire, part split, and the rest quartered. In this state they are put into  
a wicker basket, with large openings, or of loose work; and a heavy stone is put in with  
them: a rope is tied to the handle of the basket, and it is thrown into a brook of running  
water: at times it is taken up, and exposed a little to the air; it is frequently shook about  
under water, to wash off filth; and once in ten days the sticks are examined.

By

## EXPLAINED BY THE MICROSCOPE.

11

By degrees, the parts loosen from one another ; and, by gentle rubbing in a basin of water, PLATE just warm'd, they will be so far separated, that a pencil brush will perfect the business ; and afford IV. pieces of various size, pure, distinct, and clean. One part will, in this way, separate at one time, and another at another : but by returning the sticks to the water, and repeating the operation, in a course of four or five weeks, every part may be obtained distinct. They are best examined immediately ; but as one wishes to preserve them for repeated enquiries, it may be done in this manner.

Dissolve half an ounce of Alum in two quarts of water : drop the pieces, thus separated, for a few moments, into this solution ; then dry them upon paper, and put them up, in vials of Spirit of Wine. Nothing but Spirit of Wine can preserve these tender bodies ; and, till I found this method of hardening them first, that liquor often destroyed them.

---

## C H A P. III.

### Of the CONSTRUCTION of the RIND.

IT has been customary to distinguish the two outermost coats of a tree by the names Outer, and Inner Rind ; but as we have the two words, Rind and Bark, in common use, it may be more distinct to apply one of them to the one, and the other to the other.

The Rind, or outermost coat, being separated from the rest, and cleaned, appears before the Microscope like a piece of a white cobweb. It is to be examined, if fresh, in water ; if preserved, in some of the Spirit wherein it is kept ; being laid in a little cistern, hollowed in a slip of ground glass : the happiest view of it will be had by combining the sixth and seventh magnifiers of the Microscope here figured.

Although this Rind be by far the thinnest of all the parts, yet it is composed of several coats ; one laid closely over another, and all of the same kind : the great difficulty is to obtain one of them absolutely separate. In that state it appears scarce more than a shadow, or a mere delineation of lines upon the glass ; but without this, its true construction cannot be known.

The piece of Rind represented at Fig. 1, in Tab. IV. shews the necessity of this exactness : the part of it at *a* is one coat only ; at *b*, two lie over one another ; at *c*, three : in these two last portions there is a great deal of confusion : but at *a* the real structure of the part is perfectly distinct. It consists of a series of longitudinal vessels, and a filmy substance

D

between

Fig. 1.

*a b c*

*a*

## THE CONSTRUCTION OF TIMBER

PLATE between them. It might seem that there are also transverse vessels going at small distances IV. from one of the longitudinal ones to another; but this is a deception: a close examination will shew, that these are only spaces between part and part of the film.

A larger power of magnifying being used, by changing the sixth for the fourth object glass, still keeping on the seventh, we shall see the difference between these empty spaces *d*, Fig. 2. and a vascular structure, very plainly, as at Fig. 2. *d*.

To understand rightly what the filmy part of the Rind is, we must return to an examination of the transverse section, which was first viewed. In this we shall see, that the parts between vessel and vessel represent the mouths of open, oval cells: and, Fig. 1. referring this appearance to the view here given at Plate IV. Fig. 1. we shall understand that each film, between space and space, is an oblong bladder; which the knife, in the *f*, Fig. 4. transverse section, has cut through. One of these bladders, separate, is represented at *f*, *g*, Fig. 5. Fig. 4. At *g*, Fig. 5. are three or four, with their intermediate spaces, and with the longitudinal vessels continuous between them: this makes a piece of one coat of the Rind; and is a true and exact view of its composition. In Herbaceous Plants, two films enclose the whole; but it is not so in Trees.

## C H A P. IV.

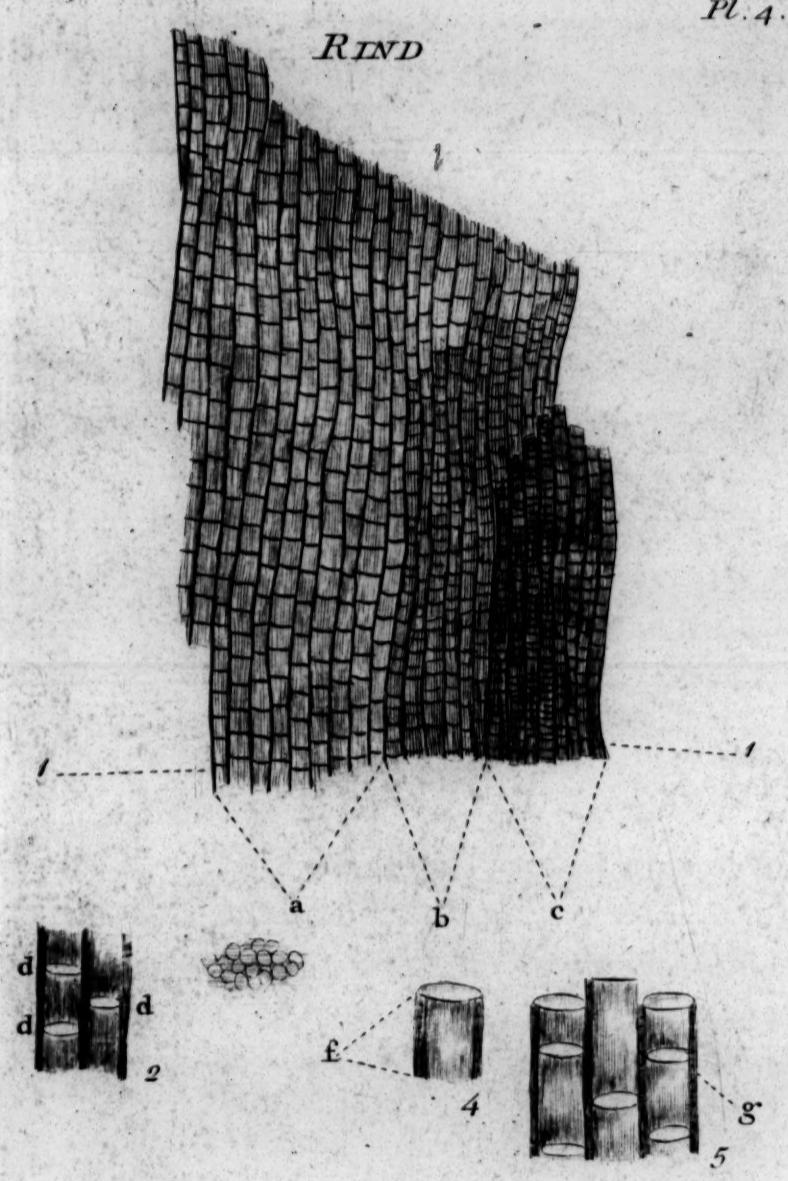
## Of the U s e s of the R I N D.

THE Rind, as thin as it is, and as inconsiderable as it may seem, is a part of the vegetable structure, of the highest and most essential use: it covers the whole tree, both above; and, what is much more important, under the ground; and contains the great and original organs by which it grows.

To take a right view of its importance and utility we must observe some yet unnoticed parts of its construction: and that these may be rendered more distinct than in their state of nature, 'tis proper to convey coloured fluids into the several vessels. The divisibility of matter has been often spoken of with wonder, but it has never been manifested to the senses in a degree at all to be compared with what is exhibited by such impregnations of vegetable parts.

*g* Fig. 4. It may be now observed, that at the letter *g* in Fig. 4. there appear dots upon the highly magnified vessels: but to know what they are requires yet greater powers of the Microscope, and more assistance. There are scarce any limits to the degrees of magnifying that may be obtained by the combination of two object glasses, of different powers, as the construction

*Pl. 4.*





construction of this Microscope admits: nor are the means of more assistance wanting; PLATE since coloured liquors may be thrown into the small vessels of Plants; and into the very V. smallest of all, liquors, which tho' pellucid and colourless when received, may be coloured after they are lodged there; altho' the matter of that colouring would have rendered the liquid too thick to have passed in the same condition.

As the vessels of the Rind are of different diameters in various trees, tho' their construction and that of the Blebs is perfectly the same in all; it will be best to choose for this purpose the Rind of a tree wherein they are largest. The advantages I receive from the garden of her Royal Highness the Princess Dowager of Wales, at Kew, (who, best of Princesses and of Women! is pleased, undeserving as I am, to honour me with her royal patronage and protection,) that garden, where every tree that has been seen in Europe is at hand, have given me opportunities of so many trials, that I can happily save the pains of others in this and all the following instances; by saying what best answers: to the present purpose the Rind of the Ash-leaved Maple is finely suited. A piece of this may be obtained of two inches long, and will very successfully answer the intention. Such a piece being prepared without either alum or spirit, but dried from the water in which it had been macerated, is to be impregnated with lead in the following manner; to shew the apertures by their colour.

Dissolve one dram of sugar of lead in an ounce and a half of water: filter this thro' paper, and pour it into a tea-cup. Clip off a thin slice of what was the lower end of the piece of Rind, as it grew on the tree, and plunge it near an inch deep in the liquor; keep it upright between two pieces of stick, so that one half or more may be above the water: whelm a wine and water glass over the tea-cup, and set the whole in a warm place. When it has stood two days, take it out, and clip off all that part which was in the liquor, and throw it away.

The circumstances here mentioned, trivial as they seem, must be attended to: the operation will not succeed even if the covering glass be omitted: it keeps a moist atmosphere about the Rind, and makes its vessels supple.

While this is standing, put into a basin two ounces of quick lime, and an ounce of orpiment; pour upon them a pint and a half of boiling water; stir the whole together; and when it has stood a day and night, it will be fit for use. This is the Liquor Probatorius Vini of some of the German chymists: it discovers lead when wines are adulterated with it; and will shew it any where.

Put a little of this liquor in a tea-cup, and plunge the piece of Rind half-way into it.

In the former part of this experiment the vessels of the Rind had been filled with a solution of lead; that makes of itself no visible alteration in them: but this colourless impregnation, when the Orpiment Lixivium gets to it, becomes of a deep brown; the vessels themselves appear somewhat the darker for it; but these dots, which are real openings, now are seen to be plainly such, the colour being perfectly visible in them, and Fig. 1. much darker than in the vessels. Plate V. Fig 1. a b.

This

**PLATE V.** This object must always be viewed dry, and is best kept in one of those Sliders which the Noble Person, to whom, in a manner, all that are called my Improvements are originally owing, has directed to be made with glasses instead of Tales.

If a piece of the Rind, thus impregnated, be gently rubbed between the fingers till the parts are separated, we shall be able in one place or other to get a view of the vessels all round, and of the films which form the Blebs between them. These last consist of mere membrane: no power of the Microscope shews any thing vascular in their structure: they are a kind of bladders, closed at bottom and open at the top, with a space, greater Fig. 2. *a a* or less, between the top of one and the bottom of another. Fig. 2. *a a*.

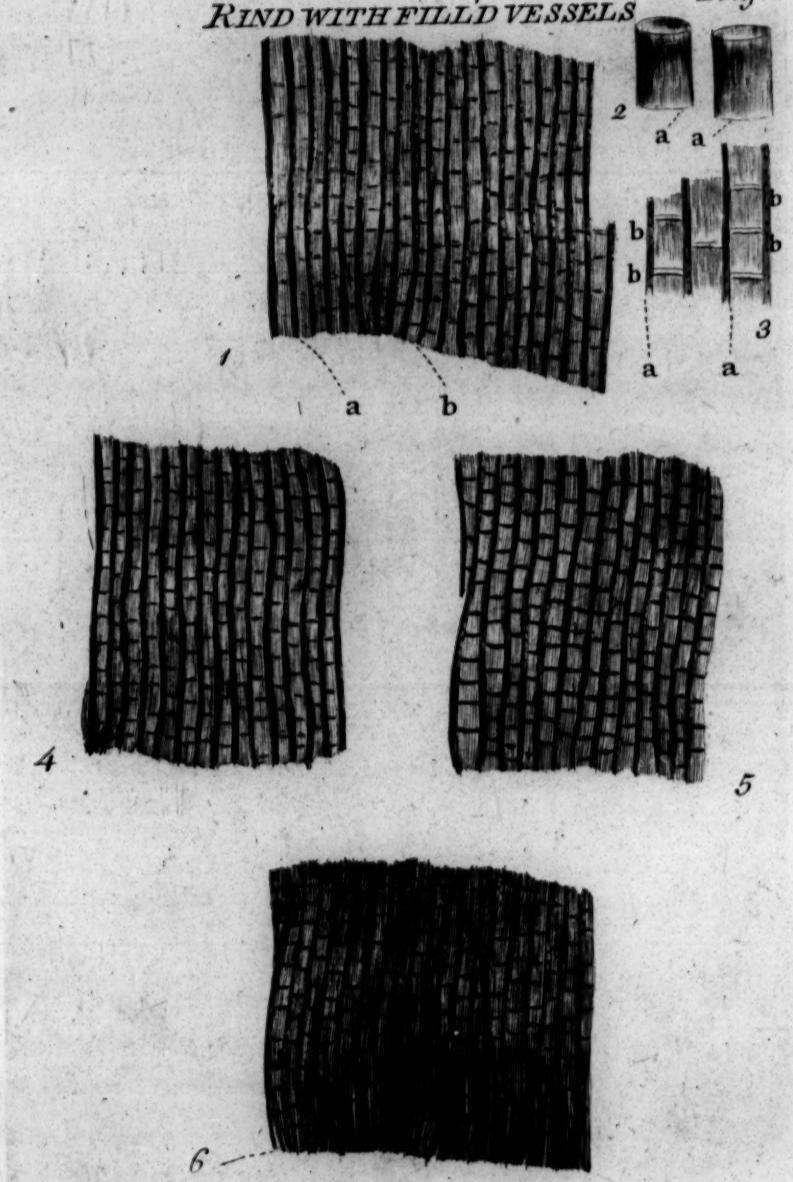
**Fig. 3.** As to the Vessels, their composition is much more to be regarded; they are every where pierced with openings; but of these the outer ones first seen, are by far the largest: there are two other series of them; the larger of which, tho' still much less than the former, are placed against the interstitial spaces, between Bleb and Bleb; and the smallest open *a b* into the Blebs themselves. Fig. 3. *a b*.

I should think it is not easy to err as to the uses of these openings; when we see their construction so exactly: and those uses, being understood, we shall have made no small advance in the knowledge of vegetation. Let us, if you please, philosophic Reader, consider them first in that part of the Tree which is under ground, the Root: here they are always surrounded with some degree of moisture: and let us, together with these objects, consider those everlasting agents heat and cold; not to say heat in its various degrees, for that were speaking too abstrusely. Heat can be no where present but it expands substances: cold no where but it contracts them.

We see a Root equalling more than a third part of the Tree above ground, in the extent of its surface. This surface is covered with the Rind, thus pierced; which is connected also with the parts underneath it. The cold of winter contracts the whole; the parts are drawn closer together; and the mouths of these innumerable vessels are shut, or nearly shut, by this contraction: a little, and but a very little, of the half-congealed moisture of the ground gets into them. This suffices for the service of the Tree, when there is little heat also to cause perspiration; and when in the deciduous Trees, (the far greater part of those of our country) the very organs of the greatest perspiration, the Leaves, do not exist.

The warmth of spring arrives: the fluids of the earth grow thinner, every part of the Root expands; this opens the mouths of the vessels, and the torrent of nutrition rushes in. A great deal of it ascends, but more diffuses itself among the circumjacent parts: the mouths of the second order deliver out a great deal to all the interstitial space; and those of the third into the Blebs themselves; and these being naturally open, soon run over; thus every part of the Rind, and every coat of it, and even the interstitial space between its innermost coat and the Bark, are filled with a fine fluid; and the whole is supple, and it then easily separates from the under coverings.

*RIND WITH FILLED VESSELS* *Pl. 5.*





The very course and progress of the fluid may be shewn in this part, even by an easier PLATE preparation; only that different Rinds must be sought for this purpose; the vessels in some being larger than in others. Repeated trials have shewn me that the whole progress may be easily marked in the three following kinds; with only a tincture of cochineal.

Put half an ounce of cochineal in powder into half a pint of spirit of wine; set it in a warm place, and shake it often, for four days; then filter off the clear tincture: put an inch depth of this into a cup, and set upright in it pieces of the Rind of Ash, White Willow, and Ozier; prepared, as has been directed, by maceration in water; for in that way one trouble does for a hundred kinds. Let an inch of the Rinds also stand up out of the tincture. After twenty-four hours take them out, clip off the part which was immersed in the fluid, and save the rest for observation.

Here is a farther instance of the divisibility of matter. Tho' colour disappears in a great measure under the Microscope, the more as the power of magnifying increases; yet in the first of these Rinds, that of the common Ash, the course of the vessels is very distinctly and beautifully seen; for they and they only are crimson. In this species the colouring liquor enters only by the open ends of the vessels; for the mouths at their sides seem too much contracted in the drying to receive it: it ascends their whole length, and shews itself at the exterior apertures or mouths, but penetrates no farther. Fig. 4.

In the Willow Rind, shewn at Fig. 5. the interstitial spaces, as well as the vessels, are crimson: therefore, among the vast variety of construction between the Rinds of several trees, the mouths of the second series are in this larger than in the Ash. It must be so; because the colouring liquor was the same to both, and only the construction of the body itself could in one instance have admitted it through passages which were closed to it in the other. Fig. 5.

In the Willow, the apertures of the third order still refusing passage to the coloured fluid, the Blebs retained their natural Olive complexion; but 'tis not so in the Rind of Ozier, where every series of mouths are open enough to let out the crimson liquor, and the whole substance of the Rind is stained with it. Fig. 6.

From hence Philosophy will judge (and it will judge with safety) why the leaves of the Ash appear later than those of the White Willow, and why the Open Ozier precedes even these. Elder and Gooseberry Rinds admit this universal tinge more readily than Ozier; but they are not so easily separated and prepared. The same philosophic truth arises also here: their texture is the openest of that in any Rinds; and 'tis therefore they appear the heralds of the Spring, and harbingers of every other verdure.

## C H A P. V.

## Of the BARK.

**PLATE VI.** **T**HE Bark very much resembles the Rind in its construction: nor can it indeed be otherwise; for the Rind was once Bark, and has only suffered a slight change in separating from it. Happily the construction of this essential part is better seen in the inner than in the outer coat of Trees; for it is more entire, more perfect: and though, in order of place, the Rind could not but be first described, it may be averred, that unless this be first viewed, the composition of the other will be very difficultly distinguished.

The Tree in which I have found the Bark most happily formed for preparation, and for observation, is the Vine. A piece of this, separated by maceration, and obtained pure and Fig. 1. free from every other substance, appears as at Plate VI. Fig. 1.

*a b c* It consists plainly of vessels, *a*; Blebs, *b*; and intermediate spaces, *c*. The obvious difference between this and the outer Rind is, that the Blebs are longer, and the vessels appear more tender. This Bark, which we examine, is one time to be Rind: the Rind that covers it is to fall off; this is to separate from its inner coats, and be exposed to the air in its place; and in this separation the Blebs shrink in their length, and the more immediate contact of the air gives a rigidity to the vessels.

Little need be said farther of this; the former, which is the same substance in another condition, having been described at large. It will be plain they are the same when the piece is applied to a greater microscopic power: the mouths of the vessels are thus shewn yet more distinctly in this than in the other; because they are here more perfect; and the construction of the Blebs and their absolute separate disposition is better seen, because they stand here farther asunder, the interstitial spaces between Bleb and Bleb having been Fig. 2. made smaller, as the Blebs were shorter by the contraction. Fig. 2.

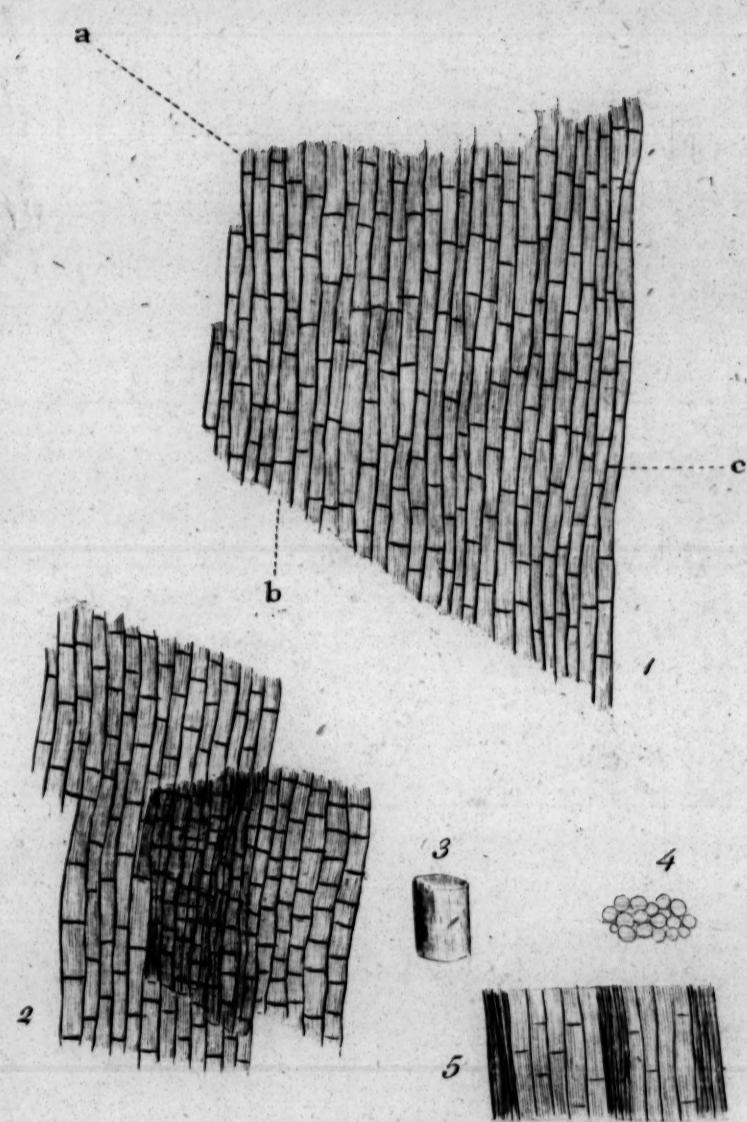
Fig. 3. A Bleb, in its natural condition in the inner Rind, is shewn at Fig. 3. It is a cylinder, close at the base and open at the mouth, as is the universal construction of all Blebs of the Bark and Rind.

Fig. 4. At Fig. 4. is given a transverse section of the Bark, by which its whole composition is seen to be nothing more than a number of coats, composed each of one row of Blebs, with vessels at their sides, laid very regularly over one another.

It

*Pl. 6.*

*BARK*





It happens that in the Vine the Vasa interiora are very distinct, and very beautifully PLATE disposed. They will be spoken of at large in their place: but it may not be unpleasing to VI. the Reader to take a view of them, as they are arranged in the substance of the Bark Fig. 5. of the Vine. They are here represented at Fig. 5. where *a a* shews the Bark, and *b b* the *bb* clusters of these vessels, keeping their regulated course together.

---

## C H A P. VI.

## Of the BLEA.

**A**LTHOUGH the construction of the Bark and Rind in Trees be very much the same, there is not that resemblance between these and the next coat underneath; the Blea. This is the part which separates the Bark from the Wood, and is of a middle hardness between them; much firmer than the Bark, but softer and more juicy than the Wood.

This may be separated as the others, by maceration: and indeed whoever proposes to himself the pleasure of these researches, should steep a great number of Shoots of the several kinds of Trees together, that where one fails another may be at hand; and that discovery which is withheld in one may be unfolded in another.

It is possible, with a great deal of care, to separate thin pieces of the Blea from the growing Shoots of some kinds of Trees, in early Spring; but when this succeeds the best it can, 'tis still very much inferior to the other method.

It may not be amiss first to view the appearance of the Blea in a transverse section: we see that way the parts and their disposition; and may trace them afterwards in their construction. If a piece of the Blea of common Willow be viewed in this way, we see that it consists of oval apertures, and a pale but intire interstitial matter. 'Tis plain the Fig. 1. openings are not mere holes, pierced in this intermediate substance; for we see they have thick sides. They seem the essential part of the whole; the rest only a something filling up the interstitial spaces between them, to preserve the Shoot in its form.

If we now place before the Microscope a thin, prepared, longitudinal piece of the Blea Fig. 2. of the same Willow, and apply a somewhat larger power than in the preceding view, we find those holes were the apertures of vessels lodged in that intermediate substance, which is floccose, white, and a mere mass, without form. Upon examining the vessels carefully, we shall perceive that their coats are composed of this very floccose substance, only more compactly

## THE CONSTRUCTION OF TIMBER

PLATE put together; and that the rest, which separates them, is nothing more than loose matter VI. of the same kind thrown off from their sides. The prepared Blea is most useful in disclosing this; for in fresh fragments the vessels and this substance seem all one common matter.

Fig. 2. At Fig. 2. a piece of the prepared Willow Blea is shewn as it appears before the  $\alpha\alpha$   $bb$  Microscope:  $\alpha\alpha$  are the vessels;  $bb$  is the interstitial matter.

The vessels of the Blea appear dotted, when seen by less powerful glasses; but here we perceive those dots are so many oval swellings, like buds on a young branch; but each swelling has as it were a mouth opening according to its length. These mouths are innumerable; they appear on every part of the vessels, and serve the purpose of keeping the whole in that continual state of moisture which is so essential to the growth and Fig. 2.  $cc$  encrease of it. Fig. 2.  $cc$ .

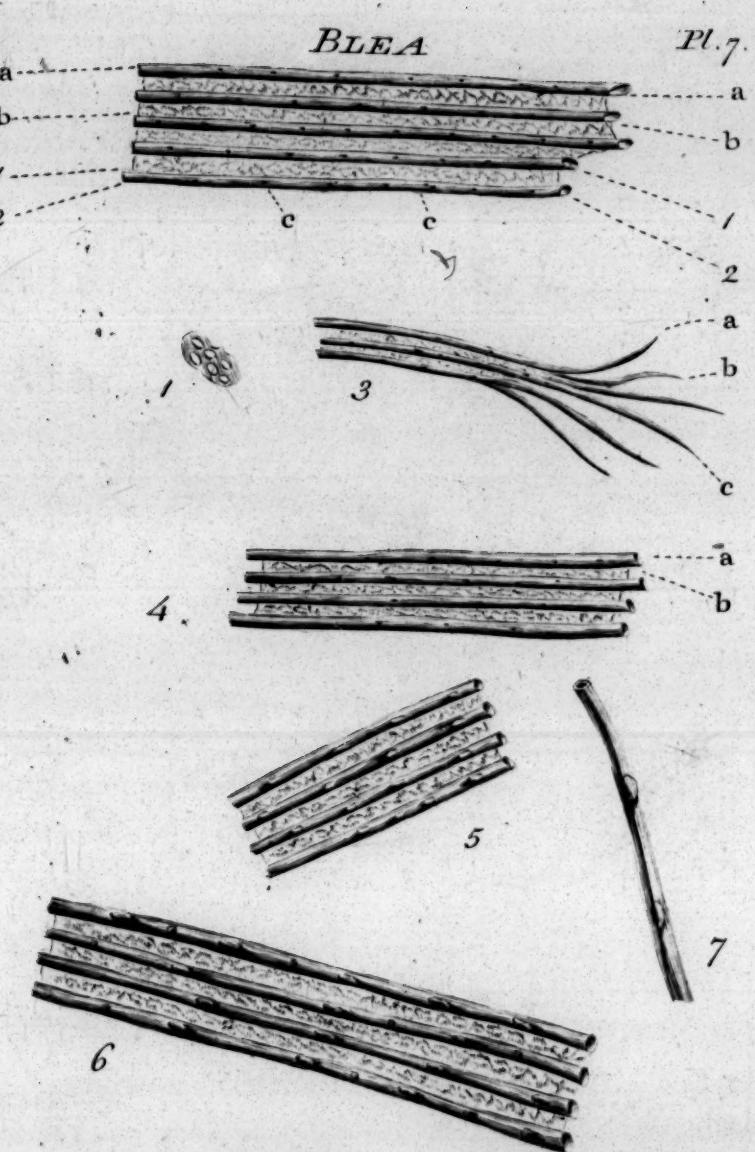
He who would see this well must not only make his preparations carefully, but cut the pieces in a fit season; either just before the first leaves of Spring, or in the Midsummer Shooting time. Then we see all the wonders of this structure; the thousands of mouths which open throughout the course of these innumerable vessels, to pour their fluid into the interstitial matter; which swelling with its quantity, like a sponge with water, presses every part outward and upward into growth and thickness. It were vain to seek them in the Winter Blea; they are shut by its contraction; and tho' a little water keeps them in that state at these times of the year, the ocean could not at an ill season open them. Even in fresh pieces of the Blea the very form of these vessels is lost, as soon as their juices leave them. Where-ever a piece is carefully and lightly torn off, the Microscope shews its vessels in their cylindric form at first; and something of their mouths is visible in the more perfect Fig. 3. end of the piece; but where they have been broken, and their juices let out, they collapse,  $a$   $b$   $c$  and nothing but a kind of flat white threads is distinguishable. Fig. 3.  $a b c$ .

The Willow was selected to shew the use these vessels have in the Vegetable Oeconomy; because in that light and loose wood the mouths are very distinguishable: but there are other kinds in which the general construction is more evident: the Pear is one: in this firm wood the vessels are much plainer, though their mouths are less; they differ also in colour from the intermediate matter; for they are brownish, while that is pure white; and being firm they are less liable to contraction.

I cannot tell whether some eyes distinguish better by the Microscope than others; whether the precise focus is less easily found by those not so much accustomed to the Microscope; or whether there be any other advantage which that great nurse of aptness, Practice, gives; but to whatever it be owing, I have found it very difficult to shew sometimes to others the things myself have seen most clearly: and I have named it in the present object because it afforded a remarkable instance.

The Blea of the fresh Willow appeared to a very careful observer all one substance; the mouths in the vessels were seen, but not the distinction of vessels and Flock. A piece of the fresh Blea of Pear Tree then was placed in view, and while we looked at it the

natural





/

natural contraction from the evaporation and loss of the fluid contained in it began; PLATE and the floccose matter shrank so much faster than the vessels could, that though the VI. ends had been cut even at first, they were soon so altered that the vessels stood out far Fig. 4. beyond the Flock, and shewed their form and separate nature most distinctly. a b

In the Ozier, taken in its season of quickest growth, in Spring, the Blea affords these vessels yet more distinctly even than the Willow; but the matter is more difficultly managed; for they are so tender, so soft, so watery, that 'tis scarce possible to keep them together. Fig. 5. shews a piece of it; in which appears this farther discovery than had been made Fig. 5. before, that the mouths of the Blea vessels all open upwards.

In a piece yet farther magnified by a combination of two of the most powerful object glasses, and with the advantage of a room constructed purposely for this service, a degree of light was made to penetrate the very substance of these vessels, and the first appearance it exhibited was that of many Cells or Blebs, such as we have seen in the Bark and Rind; but on more observation the appearance of these Cells was found to be neither equal nor regular: Nature has nothing to do with so wild constructions as seemed to shew themselves here: the truth was at length discovered: these seeming divisions altered their places; and were found only to be small portions of a watery Sap, which the contraction of the part had prevented from escaping with the rest, at the mouths of the vessels. This appearance is given at Fig. 6. and may be a very necessary lesson against hasty judgments.

A Vessel separated from this Ozier Blea is shewn by itself at Fig. 7. 'Tis strange that Fig. 7. the coat of vessels so tender should be so thick in proportion to their cavity; but this is the least compact of all Blea vessels.

## C H A P. VII.

### Of the Wood.

**A**S we proceed into the more inward part of the Shoot, in whatsoever Tree, the construction becomes more difficult of observation: the parts are harder, and less free to separate one from the other; but with due care these macerations will afford, from one kind of tree or other, pieces which will disclose its inmost structure. Many must be examined to find such; for it is not always in the Shoots even of the same species these happy objects may be found; the different forwardness of the season, the greater or less progress of the sap, and even the more or less healthy state of the particular Tree, all afford variations, and render the best sometimes inferior to those naturally much below them.

F

The

**PLATE VIII.** The common Pear Tree has afforded the instance from which the present views are given. A piece of the wood of this tree, clean, pure, and perfectly separated from other substances, is shewn at Plate VIII. Fig. 1. nothing can be so simple as its structure : tho' difficult to obtain, there is little for observation in it when we have it : only that truth is always valuable ; and when we know the composition of the wood in one tree, we can understand it in all.

The Wood then is scarce any thing more than an arrangement of plain and simple tubes, resembling the tubes of the Blea ; but that there are no mouths in them ; nor is there any of the interstitial floccose matter between them more than what fills the very small vacancies left by the roundness, between tube and tube : nay, even that disappears as the wood grows harder ; and finally, in some trees, even the tubes themselves ; their coats thickening both on the outside and within, 'till neither cavity nor interstice remains, but the whole is become one firm substance.

This may be seen in a transverse view of the common Oak ; such being chosen as has grown on clay ; for that from gravelly soils is much less compact, less weighty, and of very much less strength and value.

In the Pear, and in most other Trees, so much of the vascular appearance remains as always to make it easy to understand the structure : we always see vessels, tho' with small apertures, arranged in lines the one behind the other, in many series ; adhering firmly, and leaving scarce any interstices.

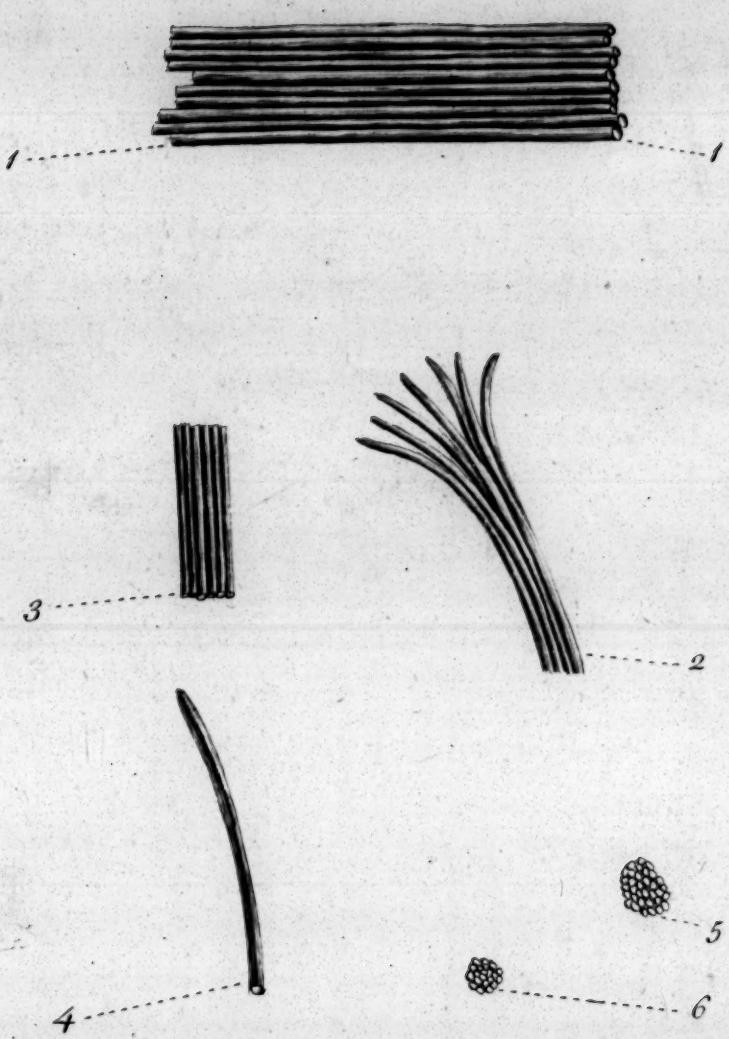
When a piece of fresh Blea is torn from a Shoot, we have observed that at the ragged end, where the vessels have been broken off, they lose their form ; collapsing, and no longer appearing any thing more than flat threads : but 'tis not so with the more firm and solid vessels which compose the Wood : they separate indeed in a piece torn thin, but they keep their form and roundness, and break all together ; not one by one ; nor forming a kind of pyramid, as in the Blea ; but an equal open termination. A piece of the fresh Blea Fig. 2. in this view is given at Plate VIII. Fig. 2.

Fig. 3. At Fig. 3. is the representation of a piece of the wood of the Bauhinia Aculeata, whose difference appears very striking ; but 'tis merely that of greater and less : the vessels in this are extremely small, very hard, and laid unusually close together. The whole viewed with the usual powers of magnifying appears one compact, uniform mass ; but greater glasses shew it formed just as the others ; only that there is so little of the interstitial substance, that even in the youngest pieces the vessels seem to fill the whole spaces, by swelling into them.

Fig. 4. At Fig. 4. is represented a single vessel of the wood of the Pear, clean separated from the other parts : this may be viewed all round, and thence we are confirmed the wood vessels are mere close canals, with no lateral apertures. The plain and simple hollow is also very well seen in these single vessels. Art would in vain attempt to procure such : they are too small to be the objects either of the hands or eyes ; but there never fail to offer

*Pl. 8.*

*Wood*





## EXPLAINED BY THE MICROSCOPE.

21

After some of them among the variety of macerations, especially of such as have been PLATE rubbed about often with the hands.

VIII.

At 5. is a section taken transversely from the bottom of Fig. 2. and at 6. a view Fig. 5. 6. of the like kind from the Bauhinia, Fig. 3. In the first we see some remains of a spungy substance between the vessels : at 6. there scarce is any.

---

## C H A P. VIII.

### Of the CORONA.

IT IS strange that among all who have written on the construction of Trees and Plants, the Circle which surrounds the Pith, and separates it from the Wood, altho' different in a high degree from both, and of a composition not at all resembling either, should yet have had no notice, and no name. It is indeed the most important part in the whole vegetable fabric ; for 'tis from this alone propagation and encrease by Branches, Buds, and Shoots, is carried on.

It has been a custom to suppose the Pith of Vegetables to be the part in which these wonderful sources of increase reside : but this theory shrinks to nothing before a careful enquiry. The state of the Pith in young Branches will be shewn in a succeeding part of this Treatise ; and it will be found discontinuous from the original Pith of the Trunk ; and so far from proceeding from it before the other parts, that it is in reality posterior to some of them in the time of its formation. This important office of encrease being given to the part to which it belongs, we shall see that the Corona is in every sense, both of construction and use, an object very worthy of a careful examination.

We have hitherto been employed about parts of Plants which are perfectly uniform in their construction. Nothing can be more simple than the composition of Wood ; and if in the Blea and in the Rind there be a more elaborate structure, still it is the same in all the Blea ; and in the Blea of all Trees. Here we have a matter perfectly different ; the Corona is not uniform, but consists of a variety of parts : nor is their nature or their disposition the same in all Trees. It is not strange this Circle should so differ from the others ; for they form and constitute only one part of the Shoot ; but in this lie the rudiments of the whole : and the Shoot or Branch which is to contain all these parts, is to receive them only from this Circle.

The Corona then is a ring usually more or less angulated in its out line, placed between the Wood and the Pith in all Vegetables. The general Circle is cellular, composed of Blebs and vessels, as the Bark and Rind, and is perfectly of their nature ; only that at

different

## THE CONSTRUCTION OF TIMBER

**PLATE** different distances are disposed among it oblong clusters of different vessels. These clusters **IX.** are usually eight or ten in number; and give origin to the angles of the Corona. They are not uniform or of one kind of vessels, as in those in the Bark, but each has two distinct sorts; the exterior ones answering to the Blea, and the interior to the Wood of Trees: and within each of these are also disposed vessels not unlike those in the Blea and Wood, and often even larger than they are found in those parts in the Shoot.

Thus we see that each cluster of the Corona is composed of all the essential parts of the succeeding Branch, and that the intermediate parts of the circle are absolute Bark and Rind, ready to follow and cloath the cluster when it goes off in the form of a Shoot; because it will then need their covering and defence, tho' in its present inclosed state it does not.

It is from this construction that a Tree is at all times, and in all parts, ready to shoot out Branches; and every Branch in the same manner to send out others: for the whole Trunk, and the Branch in all its length, have this course of eight or ten clusters of essential vessels ready to be protruded out, and the proper and natural integuments as ready to cover them.

In some trees these parts are more evident, in others more obscurely arranged; but when their nature is known, there is none in which they may not be found.

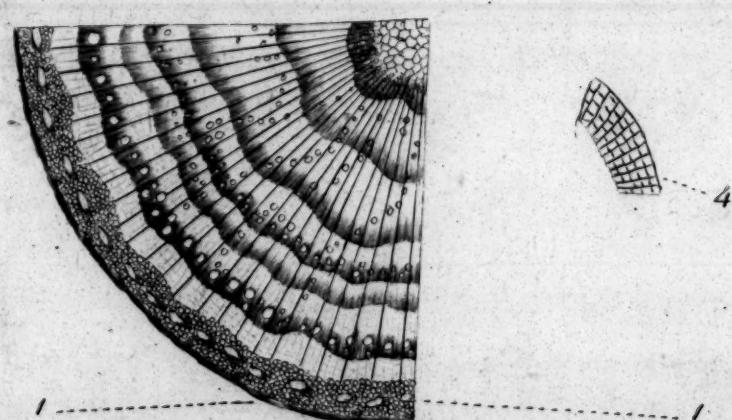
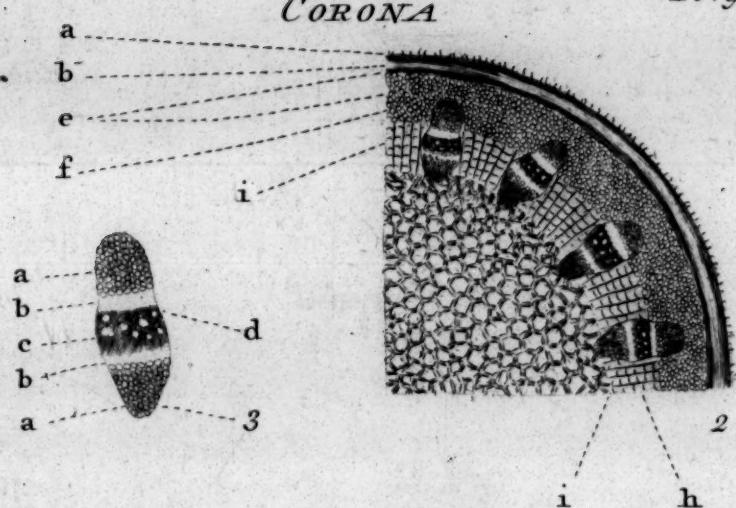
The Oak is not one of those trees in which they are most conspicuous and distinct; yet will the most cursory observer perceive, in a transverse section of a Shoot of that tree, that the circle immediately surrounding the Pith is perfectly distinct, both from the Pith which it encloses; and from the Wood which surrounds it. A section of the Oak

**Fig. 1.** is given for this purpose at Plate IX. **Fig. 1.** and near it, at **Fig. 2.** is placed a section of **Fig. 2.** that tree, in which, of all that I have had the opportunity of examining, this circle is the most distinct. This is the Parrot Wood of the West-Indies, the Bocconia of Botanical writers: it seems formed to lay open this great mystery of Nature; for nothing can be so palpable as the construction: 'twere well if this species were at hand in Europe; probably it will be soon: in the mean time, the only Vegetable wherein the parts can be seen in a manner any thing resembling this, is an herbaceous Plant, the greater Celandine; to which indeed this Bocconia is in its Botanical characters, as well as in its inner structure, very nearly allied.

**Fig. 2.** This transverse section of a Shoot of the Bocconia is given at Plate IX. **Fig. 2.** With what superior beauty must it appear from a fresh Branch: for this was from one brought from Jamaica, and rendered manageable to the knife by a long infusion in water. We see here the Rind *a*, with its Bark underneath, *b*; and the Vasa exteriora and interiora evidently mark'd in them. Beneath these, at *c*, lies the Blea, perfectly distinguishable from them, but scarce at all from the Wood, *f*, the Branch being very young and tender. But even in this state the part immediately within the Wood is most palpably distinct: its substance, structure, colour, every thing, shew that it is neither of the nature of the Wood, nor of the Pith, equally unlike both: and within this, but extending each way beyond it, are those clusters of vessels which we find in all Coronæ, tho' less distinct: these intrench upon the Pith one way, and upon the Wood itself another; being in their

nature

*CORONA* *Pl. 9.*





nature and office of much more importance than both. At *b* is shewn the substance PLATE of the Ring or Circle, the immediate matter of the Corona; and at *ii* the clusters of vessels which at their egress from the tree are to form Branches: this matter of the Corona always follows out in quantity enough to cloath them.

One Cluster, separated from the Ring, is represented more enlarged at Fig. 3. In this Fig. 3. we palpably see the substance of the Blea and the Wood, and yet more evidently the vessels of that latter part. At *a* the loose and open texture of the Blea cannot be mistaken by any who are at all accustomed to these observations: at *b* the closer structure of the wood is perfectly disclosed: and at *c* a part of the same wood surrounding the great vessels; but of a softer substance than the other, that it may not be capable of pressing those vessels, on whose free course the growth of the whole Shoot, to arise from this cluster, perfectly depends. At *d* the great vessels themselves are shewn, not at all exaggerated by fraud or fancy, or the rage of system. It is just so they appear, and will always appear; even in the herbaceous Celandine; as well as in the arborescent Parrot Wood.

At Fig. 4. is given also an enlarged view of the substance of the Corona; in which, as in Fig. 4. all just opinions, the greater power we employ to examine, the more light is thrown upon the subject. If it had been possible before to doubt the nature of that circle; under this advantage of greater magnifying, it is not; the structure of Rind and Bark are so distinct in it, that an accustomed eye would declare at once, that it was a view of those two parts taken from some very good subject which he had before him: they would appear the absolute Rind and Bark of a Shoot, not their embryo's in the Corona.

On the Corona and its Clusters, (for in Nature they are never separated,) on this complex part depends that incomunicable property of Vegetables, that they can be produced entire from every piece. In animals, even where bounteous Nature has given the wonderful advantage of a re-production of parts, still it is but the part which was lost that can be so produced. The leg of a crab being broken off, a new one grows in its place: but then it is only a leg. Nay, even in Spalanzani's great experiment of the jaw of the Newt, when that part is cut away, 'tis that part and no more that grows again: but in Vegetables the whole arises from a part; and that from every part cut off transversely, with almost equal ease.

These Clusters follow the course of the other portions of the Tree; they are therefore every where: they are always capable of growing; and their growth, even in a cutting of the smallest twig, cannot produce a leaf or any other part of a vegetable alone, but must afford the whole; for they are complete bodies, and the whole is there, waiting only for the means of extension, sufficient nourishment.

'Tis hence in all trees Shoots thrust forward from the Crowns and sides of Branches in Spring, and after Midsummer, the seasons when the vessels are most fil'd; and hence that at all seasons, under sufficient shelter and defence, Branches rise from the naked cuttings, under the Gardener's care. That they do not rise with equal ease and readiness from all kinds of trees is owing merely to the difference of construction in

## THE CONSTRUCTION OF TIMBER

PLATE these Clusters of the Corona. In those species where that spungy matter of the wood, VIII. *d*, Fig. 3. is very loose and open, the cuttings grow very freely : in those where the same *d*, Fig. 3. substance is much more compact, and presses more upon the vessels, they grow more difficultly ; and where it is very hard, they will not in the common method grow at all. It will be worth the practical Gardener's while to attend to this : for to raise such trees from cuttings there requires only to wound in many places this interior woody substance, and that way to give the vessels freedom. He must not be expected to use Microscopes to find them out, 'tis sufficient that he be told in general where they are ; they lie deep, just above the Pith ; and when he would raise a Tree or Shrub of the harder kinds from cuttings, he is only to cut deep into the piece all round, as surgeons scarify : he will destroy many of the parts ; but enough will remain to furnish matter for some Shoots.

Something of this truth seems to have been conceived by practical Gardeners ; some of whom have recommended slitting, slashing, or pricking holes in the part of a cutting or slip to be put into the ground. Others have decried the practice ; and, as they say, from ill success upon the trial. Both may write truly : but they have judged too generally on a subject where the matter depends upon the different structure of particulars. He that cuts or pierces a soft species, where the part surrounding these vessels is loose and open, lets in destruction and rottenness to the whole : but he who performs the same operation upon kinds where it is hard and too compact, gives course to the natural powers and method of increase. If these kinds be scarified, and the others secured by wax from the too free ingress of the moisture of the earth, few will fail.

## C H A P. IX.

## Of the PITH.

**I**N the center of every young Shoot of a tree resides the Pith : greater in some, and less in others ; but present in all. It is placed close within the Corona ; the moistening of whose clusters, and giving moderate and regulated way to their extension, is its great office : for the thing itself, and its destined uses, have been mistaken. It is supposed coeval or primordial to all the other parts ; but it is indeed postnate, and comes after them in the order of time, as well as in its uses. It is no other than a cellular substance, formed from the inner surface of the Corona, when the growth of the clusters of that part begins. We see nothing of it in the Corona itself, tho' ever so carefully examined ; for it does not exist in that part while dormant : but as soon as a cluster leaves the circle, and its parts separate for growth, this spungy matter is formed within them. Exhaled air gives origin to its Blebs, while the thickness of the juices, cloathing the Bubble, give it form and substance.

Thus

Thus is this interior substance formed, which has been supposed primeval, and the great PLATE cause of production, of all the rest. Its office is required only while these clusters take IX.  
their first growth, and it acts no longer. The first season is the time of its great use, and it immediately after begins to decay.

Thus we see trees have parts of limited and temporary use. The great vessels of the wood perform their office for several years; but it is only at particular stated seasons: in Spring and at Midsummer we find them in their duty, full of their proper fluid; at other times vacant and inactive: the Pith, in the same manner, lives and acts for the first year; and scarce longer.

The structure of the Pith has been as little understood as its office: figures have been published of it, representing it as formed in circles, hexagons, and polygons, with starry points, and double lines, and an infinity more of various configuration: yet the thing is but one. To see it truly, we must look where it is most simple. The Walnut affords it in this condition. If we split a Shoot of the common Walnut, of the growth of one season, directly down the middle, we see the central part divided across into several cells by thin membranes, as in Plate IX. Fig. 1. 2. Each of these cells is oblong, Fig. 1. 2. smallest at the ends, and larger in the middle, as Fig. 1. a. and examining the smaller Fig. 1. a. part we very distinctly see two membranes forming the two sides of the cell, and separate from the membranes of the cells above and below, tho' they join the one and the other in the middle b. Following the course of this surrounding membrane round the whole of any one cell, we see that cell in its true nature: it is an oval Bladder or Bleb, of which this membrane forms the oval. Such a one is represented alone at Fig. 3. The whole of the Pith is the same with its parts; therefore the Pith of the Walnut consists only of one range of these bladders, smaller at the edges, largest in the middle, and laid very exactly one upon another. The Corona of the Shoot keeps them in their place sideways: they have no weight, so they do not press upon one another downward; and therefore they retain this form.

It is only in very few trees that the Pith is of this simple construction; but having seen it thus in one, we shall understand it in all. It is the quality of the Corona to throw out little bladders of air, closed in thin membranes; they are large in the Walnut, and therefore each reaches across the whole branch; but in other trees they are small; and many of them must be laid horizontally together to extend from side to side of the Shoot. In the Dog-Rose, represented at Fig. 5. we see it takes ten or twelve circles of the Pith Fig. 5. Blebs, to fill the vacant middle of the Branch: but still these Blebs are the same as in the Walnut; only that here they are small and round; in that large and oval.

One of these Blebs, separated from those above, below and on each side of it, appears as at Fig. 6.

Fig. 6.

It will be observed that at Fig. 5. where the whole body of the Pith is represented Fig. 5. together, the outline of every Bleb appears double; and, as it were, jointed in several places. This is one of those wonders which have been represented in elaborate engravings:

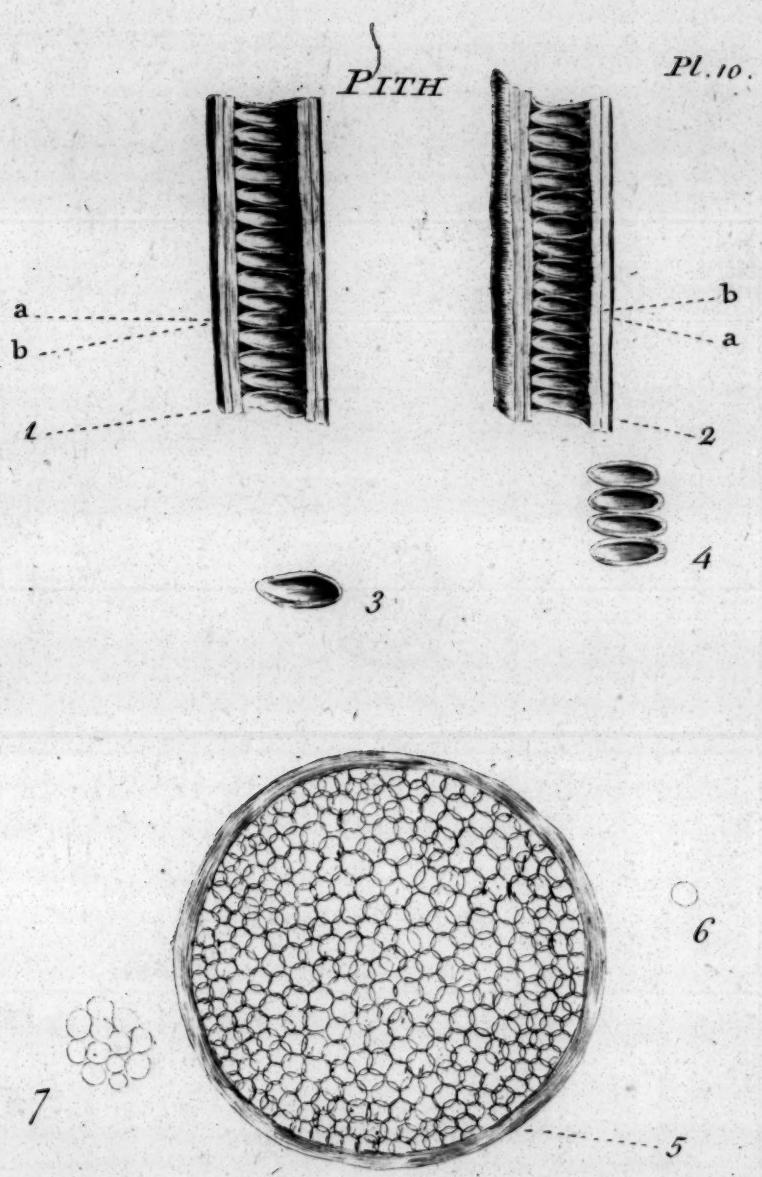
PLATE but it is the mere deception of the eye, viewing a thickness of the Pith in which a great  
IX. many beds of the Blebs are seen together, lying over one another. There is no difference

Fig. 6. in the form of one Bleb and another ; and we have seen at Fig. 6. what one Bleb is.  
Its membrane is simple, and its outline is single ; but here the outlines of many Blebs are  
seen one over another, and variously intersecting one the other.

It has been the custom to view such a slice of the Pith as could be cut off thin with  
a razor ; but the most careful way of executing this takes in many courses of these Blebs.  
In a slice cut to one thousandth part of an inch, by the engine here figured, a great part  
of this deception vanishes, because very few beds of the Blebs are taken : and in one  
of the fifteen hundredth part of an inch, (for the instrument will afford such) the whole  
error vanishes. We see the thing as it is ; one simple arrangement of cut Blebs. Such  
Fig. 7. a piece is represented at Fig. 7.

With respect of those other figures supposed to exist in the Pith of Trees and Plants,  
I have sometimes exemplified their appearance by the structure of a piece of gauze ; which,  
tho' composed only of strait lines, perpendicular and horizontal ; that is, forming simple  
squares ; yet if it be laid double, a new arrangement of lines appears ; and if again  
doubled, yet another ; and so on, till, at six times doubled, the variety is in a manner  
endless. The difference of figures cannot be more between the appearances of the Pith  
of different trees, all made by simple circles, than in these which ourselves have formed  
of simple squares.

Thus ends the examination of the several constituent parts of Timber. These are all :  
They are essential ; for they are found in all kinds ; and they are here represented as they  
have appeared, in repeated observations, to the Author, to his noble Patron, and to many  
assemblies of philosophic friends. Nothing is enlarged, nothing altered from what the  
light received in those several views : if in any part that has been yet deceived, let it not be  
imputed to purposed misrepresentation. Nothing is feigned : if in any thing he has erred ;  
Reader ! thou art a man, and pardon human frailty.





---

B O O K II.

Of the VESSELS of TREES.

---

C H A P. I.

Of the VASA PROPRIA EXTERIORA: or, The Outer Range of peculiar  
VESSELS in TREES.

THE Vasa propria, or peculiar Vessels in Trees, are not of the nature or condition of PLATE their constituent parts, already described. These last are essential to the nature of a Tree, as a Tree: the others are accidental, and belong only to the species. The Vegetable Structure can exist without these: but it cannot without the others. They contain the particular juices on which the virtues, qualities, and specific properties of Trees depend. A Tree can grow and live, and give shade without them; but it cannot have eminent qualities. Those are greatest where these Vasa propria are largest or most numerous: and where we scarce see these, we hardly taste or smell the other.

Of these Vessels there are many ranges disposed in or between the several parts: their situation could not be understood from description, until those parts were particularly known; but now they will be traced with ease.

Of the Vasa propria there are four kinds; and of these each has its allotted place, its peculiar form, its different structure, and its separate use. Some trees have them in all their parts; others in some of them; and there are which shew them not at all. Where they are not discernible by the eye, reference is to be had to the taste; for if there be nothing perceived by that, where none appear to the sight, it may be reasonable to give over the search, and conclude there are none.

## THE CONSTRUCTION OF TIMBER

PLATE To follow the order of their arrangement in the Tree, their kinds are these :

- XI. 1. The Vasa exteriora, lodged between the Rind and the Bark. 2. The Vasa interiora, situated in the Bark. 3. The Vasa intima, lodged in the Blea. 4. The Vasa peculiaria, in the Corona. Beside these, there are the Sap Vessels in the Wood; but they are common to all Trees.

The first of these, the Vasa propria exteriora, have been shewn in their place and proportion at Fig. 3. where they appear as round dark-coloured bodies, lodged between the Rind *a*, and the Bark *b*, and entrenching upon the substance of both, making their own beds half within the Bark, and half within the Rind.

To know their structure we must carefully separate the outer Rind from the inner Bark; and this may be done, with some attention, in a living Shoot, just at the time of its swelling for the Spring, or for the Midsummer Shoot; but much easier by the means of maceration.

When the Rind is perfectly separated that way, it leaves the Vasa propria of this class behind it: they scarce adhere to the inner Bark; not at all to the Rind; and therefore lie undisturbed upon the piece thus stripped. We see them as represented in Plate XI. at Fig. 1. Fig. 1. they are disposed in little packets, like cords, and do not run strait down the Branch; but interweaving with one another, form a very pretty kind of net.

When we raise any one or more of these packets of Vessels, we perceive that it here and there sticks a little to the substance of the Bark, but no where to the other vessels: they part very freely where they pass over one another, and will indeed fall asunder in those places, if they be clipped short, and shook about in a paper.

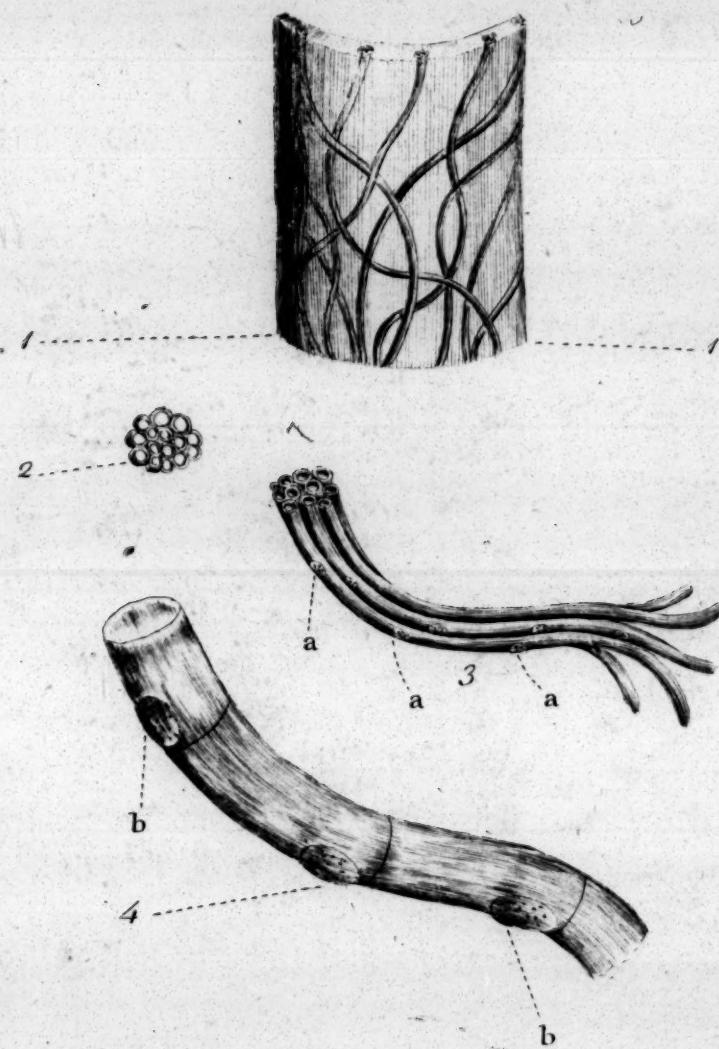
When we examine a thin transverse piece of one of these packets, we perceive that it is composed of twelve or fifteen distinct vessels, whose Rinds seem hard, and must indeed be so; for they preserve their roundness notwithstanding their mutual pressure of one another, Fig. 2. and the pressure also of the Rind and Bark. A view of such a piece is shewn at Fig. 2.

Laying several longer pieces of these packets before the Microscope, we shall, with a great power, find some happy fragment in which we may see the cause and nature of the adhesion of these parts to the Bark. Such a view is given at Fig. 3. We see at one end the vessels *a a a* of the packet a little separated, and in the parts *a a a* we perceive upon the sides oval depressions, dotted as it were with pin holes; these are most probably a kind of glands, which separate, from that general store of sap with which the Bark is filled, the peculiar juices which are found in these vessels.

A great deal of patience, a vast number of objects, a good Microscope, and a fair day are requisite for viewing the Vasa exteriora, for this purpose; but he who takes all these precautions will not be disappointed.

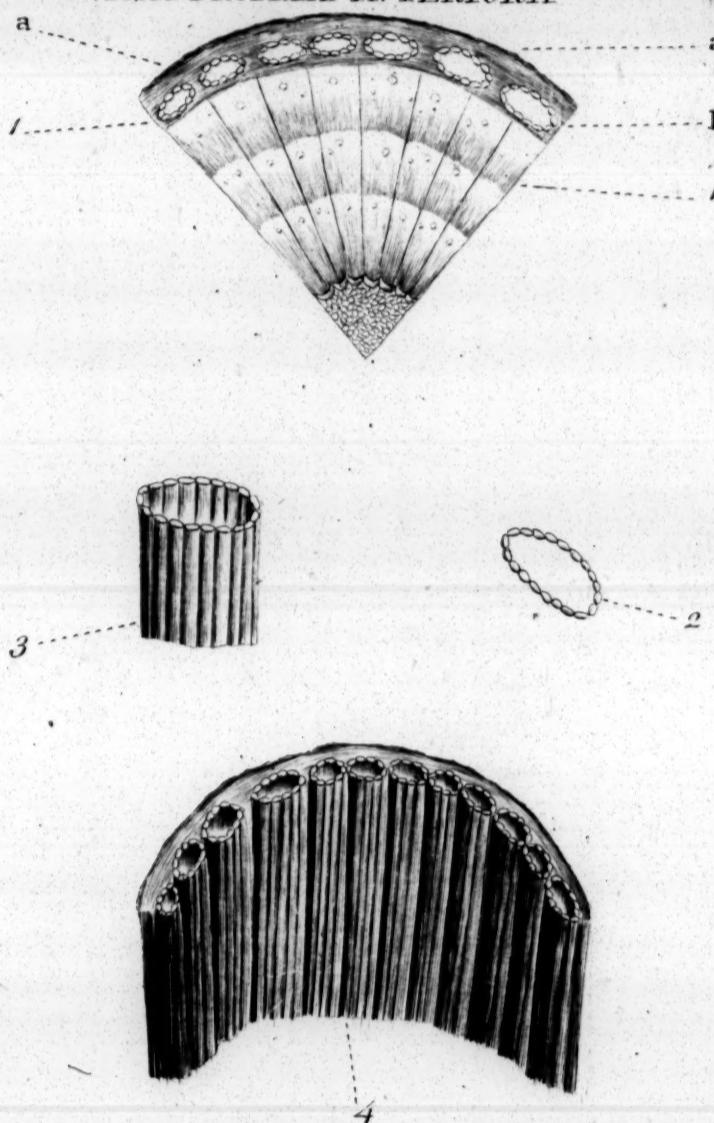
*Pl. II.*

*VASA PROPRIA EXTERIORA*



*Pl. 12.*

*VASA PROPRIA INTERIORA*



If some of these packets be worked about with gentleness, the open ends will give an opportunity of getting some vessels separate and single. These being put into spirit of turpentine, will, after a week's standing; become very transparent: and one of them, viewed with a great power, appears as at Fig. 4. divided in a very wonderful manner transversely into cells: these are short, oval, and terminated by hollow valves; and usually, some of them being full, and others empty, the construction is very prettily shewn. We see at *bb* some parts of those pin hole glands; and it is singular they always have their origin at the base of a cell longer than the others. The brownness of the concreted juice in the Oak, from which all these observations are taken, renders the cells which are filled very distinguishable: but there are other vessels, with colours more distinguishable still, to be mentioned in the succeeding chapters.

Fig. 4.

*bb*

## C H A P. II.

## OF THE VASA PROPRIA INTERIORA.

THESE are Vessels generally of more importance than the preceding; and often of more than any other part of the Tree. They are in such kinds as are renowned for medicinal virtues usually large: they carry the milk juices in the Sumach; and the greatest quantity of the turpentine, as also the finest and highest flavoured, is lodged in them, in all the kinds of Pine. Their situation is shewn in the Oak in Plate III. at letter *d*; but tho' they are of no moderate size in that Tree, they are yet much larger in the Pines; we should therefore select a Tree of that genus for the tracing them in the present instance, if there were no other cause of preference: but 'tis our business to see them as clear and free from their juices as possible, in order to understand their structure; and happily the juice which fills them in the Pines, being a pure turpentine, is capable of a perfect solution in spirit of wine.

The species of Pine in which these Vessels are seen most of all distinctly, is the *Pinus Orientalis* of the Botanical Writers. They are vast apertures in every kind of Pine. If we view them just cut we see bubbles of a yellow turpentine rising out of them. If a thin transverse slice is laid before the Microscope, after soaking in spirit of wine, they appear as great oval holes, into which straws might be thrust without doing them violence. Such a section of the Oriental Pine is given at Plate XII. Fig. 1. where we see a chain of these vast apertures regularly placed in the substance of the inner Rind, and conforming themselves to the shape of the Branch.

Fig. 1.

It

S

## THE CONSTRUCTION OF TIMBER

**PLATE XII.** It cannot but be observed, even by the least curious, that the outline of these vessels is composed of a Ring of oval apertures, *b*: these are in reality the mouths of other vessels; and the result of the observation is, that the very coats of these vessels are themselves vascular. A view of an arrangement of these vessels, as they appear in a transverse Fig. 2. Slice cut from one of the Vasa propria of this Pine, is given at Fig. 2. These vessels appear, by the strictest enquiry I have been able to make, to be of the same nature with those which constitute the Packets in the Vasa propria exteriora; so that if we conceive one of those Packets opened in its center, and the vessels driven every way outward till they are stopped by the substance of the Bark, they will give us an idea of the structure of the Vas interior, which is no more than a great cylindric hollow formed in the center of Fig. 3. such a Packet. A view of such a vessel, as taken out of the Pine, is given at Fig. 3. Fig. 4. and at Fig 4. is represented their exact disposition in a somewhat older Branch, where the hardening of the parts has driven them close together, and where they appear as in the hollow of such a piece; the Wood Blea, and even part of the Bark, being pulled away. Few Trees afford more beautiful objects than a piece like this, of the Pine, before the Microscope here described, used in the oblique manner.

From what we have seen of the construction and use of the Vasa exteriora, the nature of the purposes these answer in the Vegetable Oeconomy is not hard to trace. If, as is most probable, the vessels of the coats of these, are the same with those, they are filled with the essential juices of the Rind; and from those cells 'tis probable that they discharge the matter they contain into these great receptacles, thro' apertures in that part of their surface which forms the inside of these vessels: but this is no more than opinion. Conjecture must be carefully distinguished from observation; and it must be owned it may err here: for these vessels are small, and so difficult to be got at, that I have never been able to see either these openings, or their contents. But whether it be by these or by any other means the Vasa interiora are supplied, their office is certain; they hold the rich juice, secreted from the nourishment of the plant, perfectly separate from all the other fluids: and from their situation in the outer Bark, it is evident whence it happens that in this part we find the virtues and the flavours of Vegetables most reside.

## C H A P. III.

## Of the VASA PROPRIA INTIMA.

NOTWITHSTANDING that there are in the construction of a piece of Timber PLATE two arrangements of Vessels within these Intima; the great Sap Vessels of the Wood, XIII. and those of the Corona; yet as the former are not of the nature of the Vasa propria, (not carrying any peculiar juices, but only Sap, which is nearly the same in all Trees) and as the others are not of one kind, but a mixture of several, and indeed are only repetitions in miniature of these, and the preceding; the Reader will not dispute the name Intima to the present.

They are large, conspicuous, and very important vessels: their natural place is in the Blea; the part of a Tree which lies between the Bark and the Wood: they are never seen in any place exterior to this, but sometimes they are repeated in the very substance of the Wood; nay, and in the Corona itself; in some degree displacing and intercepting the other parts.

It is very essential to see these in a Tree where they are most conspicuous; for their being thus intermingled among other parts renders them in many instances obscure: at least the best observer will be able to find them much the more readily in other kinds, from having once seen them where they are thus obvious. Their coats are thicker than those of any other vessels; but in some kinds they have also a colour in their contents that renders all doubt concerning them impossible.

The Tree in which they appear most palpable of all, is the Piscidia Erythrina. In these they have a scarlet colour, never to be overlooked: and it happens that the other parts lie so conspicuous and so regularly about them, that they must be known every where, for ever, by any one who has once seen them here. A view of a transverse section, from the Shoot of this Tree, is given at Plate XIII. Fig. 1. In this the Vasa propria interiora (*a*) Fig. 1. *a* hold a distinguished place; and just within their circle lie the intima; large, single, conspicuous, (see the letter *b*) disposed in a manner perfectly singular; certain assemblages *b* of them, about three in number, following their exact course in the Blea, but alternately arranged in lines and triangles. Besides these there appears here and there one of them loose and unarranged among the Sap Vessels of the Wood, as at *c*. And in the Corona *c* there appears at *d* a perfect circle of them, in the same alternate arrangement of lines and triangles.

## THE CONSTRUCTION OF TIMBER

**PLATE XIII.** The Reader will be pleased to observe, that in this and all the other figures of sections given in this part of the Work, the Vessels intended to be particularly shewn are the only finished parts. The construction of the rest is thrown in shadow that the eye may not be confused. There is more in the Piscidia worthy of note beside these Vasa intima; and it will be figured again with that view hereafter.

The exact situation of the Vasa intima in this Tree is always subservient to that of the Vasa interiora: those are placed near the inner edge of the Bark, and the intima keep a nearly exact distance between them and the Wood; three of them appear to accompany Fig. 2. one of the interiora, as in Fig. 2.

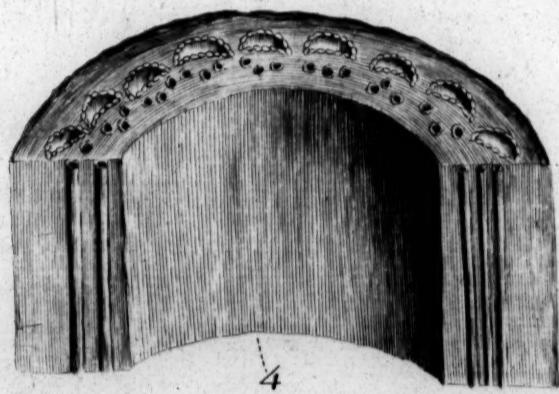
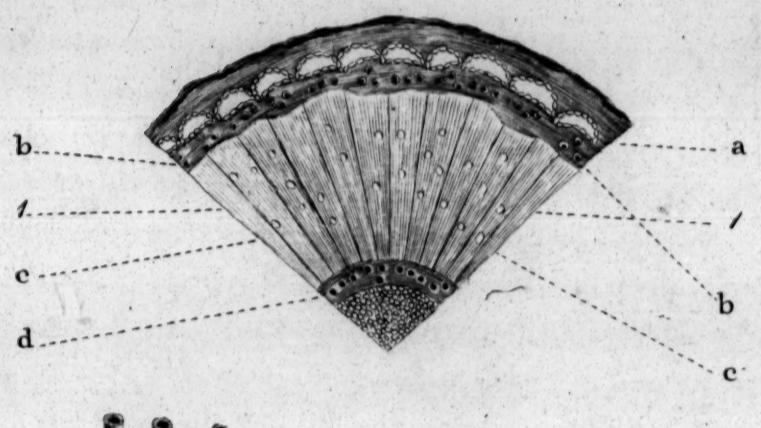
It is not at all difficult, after a successful maceration, to separate some of these vessels from the Blea: in that state they appear perfect cylinders, with thick white coats, filled with a hard red juice: and, so far as I have been able to see, perfectly uniform on their Fig. 3. surface. Some of them, thus separated, are shewn at Fig. 3. It is thus alone we can view them by the common powers and apparatus of Microscopes; but 'tis not thus they are seen in their greatest beauty—To obtain that view a piece of a young Branch of the Piscidia is to be cut into short cylinders; one of these is to be split; and after just so much maceration as will loosen the parts one from another, the Wood is to be got away. This is best done by means of a small hollow chissel, shaped like the half of a quill. The opening is to be made with this, and then the Wood pulled away with a pair of fine pincers. The part where the chissel passed is to be cut off and thrown away, and the rest preserved for observation. Many pieces should be treated in this way, and chissels of many sizes used for this purpose; for 'tis only by that variety, and among a number of pieces, that one or two can be found happily cleared of the interior part. One of these pieces, Fig. 4. successfully cut, is represented at Fig. 4. And beside the Vasa interiora, which make a very pretty appearance in such an object, we see these intima in every view we could wish: upon the top of the section we see their white mouths filled with a crimson concreted juice; and upon the split sides we scarce ever fail to see several of them in their whole length; for their coats are so strong, that they very seldom tear; but usually stand out in their places.

The coat of the Vas intimum has nothing of that vascular structure of that of the interius: it seems one firm, solid, uniform, woody substance, formed to keep the precious juice it contains in perfect security. It must not be omitted here, that this juice, in the present instance, is of a substance so compact when dry, and is so firmly united every way to the sides of its vessels, that preparations once made of the parts will never lose their character. If a transverse section be cut of but the thousandth part of an inch in thickness, and be immediately plunged in spirit of wine, the Vessels, when the whole is viewed in a few drops of the same spirit, appear as so many rubies: and so firmly does their contained juice keep its place, as well as colour, that many years steeping in the same spirit does not dissolve or separate it. I would not venture to relate so strange a thing, but that I have many Slices now in spirit which are unaltered in six years keeping. The matter of colour is so important in this object, that a second Figure is given with that advantage. What this indissoluble juice is, (for neither does water affect it otherwise than by destroying the parts in which it is lodged) or what may be its qualities, is a thing very worthy of trial. How great is the difference between this and the Turpentine of the Vasa interiora, which the same spirit clears away with the greatest ease!

C H A P.

Pl. 13.

VASA PROPRIA INTIMA





## C H A P. IV.

## Of the SAP VESSELS.

IT cannot but have been observed, that in our Hd Plate, where all the parts of a Tree PLATE are shewn together, the most numerous, as well as the largest apertures, are in the XIV. Wood. All apertures seen by this view are the ends of vessels cut thro' by the instrument; Fig. 1. and the size and number of these command the first attention. They are in no Tree larger than in the Scarlet Oak of America. We have seen the appearance of a thin Slice in that Plate; but it will be proper to give here an idea of their disposition in a split truncheon of the same Tree; such as the former. If a short cylindet of a three years Branch of this Oak, a little macerated, be hollowed away with a chissel so far as to take out the Pith and the Corona, it appears at Plate XIV. Fig. 1. The Blea and Bark are there also pushed away, so that the Wood forms almost the whole of the cylinder; and it is wonderful to observe how large a portion of this is occupied by these large apertures.

On the sides of the split piece we see these Vessels very conspicuous; for they are very thick: and it is not difficult, with some care and attention, to loosen several of them.

If a number of these, thus separated, be put into a vial of rain water, and frequently shook for several days, some will at length be found perfectly clean. These are to be then put into spirit of wine; and when that has been two or three times changed, they will be in a condition to be viewed for understanding their structure. Some of these are represented, as they appear to a great power of the Microscope, at Fig. 2. where, notwithstanding all the violence that has been offered them, there will still be seen in many of them the remains of valves; by which doubtless these Vessels in a state of nature are divided into many cells. Fig. 2.

In the Willow-leaved Oak these Vessels, tho' somewhat smaller, are firmer and more compact than in the Scarlet kind; and having thicker coats, are fitter for examination. In the Vessels of the Scarlet Oak nothing could be seen under the name of a coat but a mere membrane, resembling a piece of thin parchment. In these, as represented at Fig. 3. the coat is a palpable ring, in which traces of lines surrounding one another may be seen; by which 'tis not difficult to understand, that it is composed of several membranes covering one another. It has happened in some pieces of these Vessels, long shook about in water, that the outer membrane has separated itself like the hull of an almond in blanching; and in this state we not only see that there is such a membrane, or probably a number of such membranes, but also that they are vascular, as at Fig. 4.

Fig. 4.  
A split

PLATE A split and hollowed piece of the Willow Oak is represented at Fig. 5. in which the  
XIV. thick coats of these Vessels render them very conspicuous.

These Vessels, which are, in nature, cisterns of Sap for the feeding the growth of the whole Tree; and from which it bleeds so freely in the Spring and at Midsummer; are so large that they are capable of being filled with coloured wax, in the manner of the vessels in anatomical injections; and this way they afford so pleasing objects for the Microscope, and give such excellent opportunities of tracing their course and structure, that it would be invidious to conceal the method from the curious Reader.

A view of pieces of the Oak, thus treated, and of the effect it has upon their Vessels, is given in the additional Plate XIV.

The Method of filling the Vessels is this:

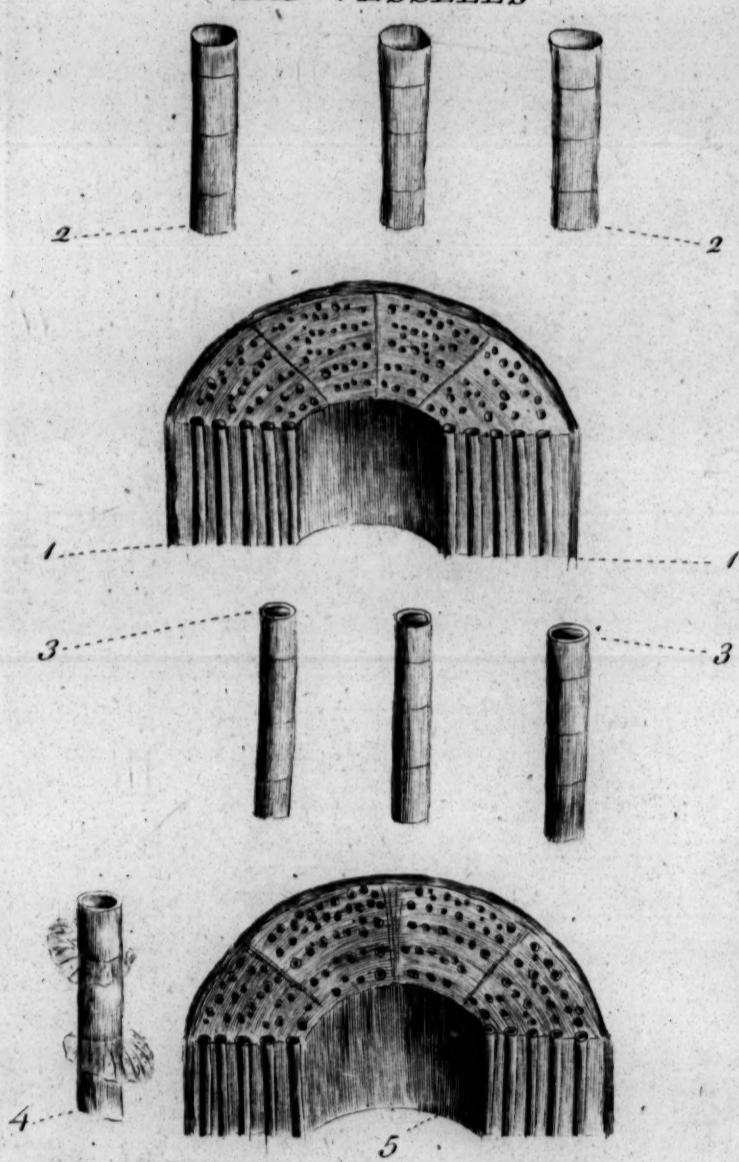
A great many pieces of the Scarlet and other Oaks are to be taken off in Spring; they must be cut into pieces of about two inches length, and immediately from the cutting they must drop into some warm rain water: in this they are to stand four and twenty hours; and then be boiled a little. When taken out they are to be tied on strings, and hung up in a place where the air passes freely, but the sun does not shine. When they are perfectly dry, a large quantity of green wax, such as is used for the seals of law deeds, is to be gently melted in an earthen pipkin set in water, the water to be heated and kept boiling. As soon as the wax runs, the Sticks are to be put in; and they are frequently to be stirred about. They must be kept in this state about an hour, and then the pipkin is to be taken out of the water, and set upon a naked fire; where it is to be kept, with the wax boiling, for two or three hours; fresh supplies of the same green wax being added from time to time.

After this it is to be taken from the fire, and the Sticks immediately taken out with a pair of tongs. When they are cold, the rough wax about them is to be broken off. Both ends of each Stick are to be cut off half an inch long, and thrown away; and the middle pieces saved. These are then to be cut into smaller lengths, smoothed at the ends with a fine chissel, and many of them split in various thicknesses.

Thus are obtained preparations, not only of great use, but of a wonderful beauty. Many Trees afford handsome objects as well as the Oak; and in some, where the Sap Vessels are few, large, and distinct, the split pieces resemble striped satins, in a way scarce to be credited. It is in such that the outer coats of these Vessels are most happily of all to be examined.

*SAP VESSELS*

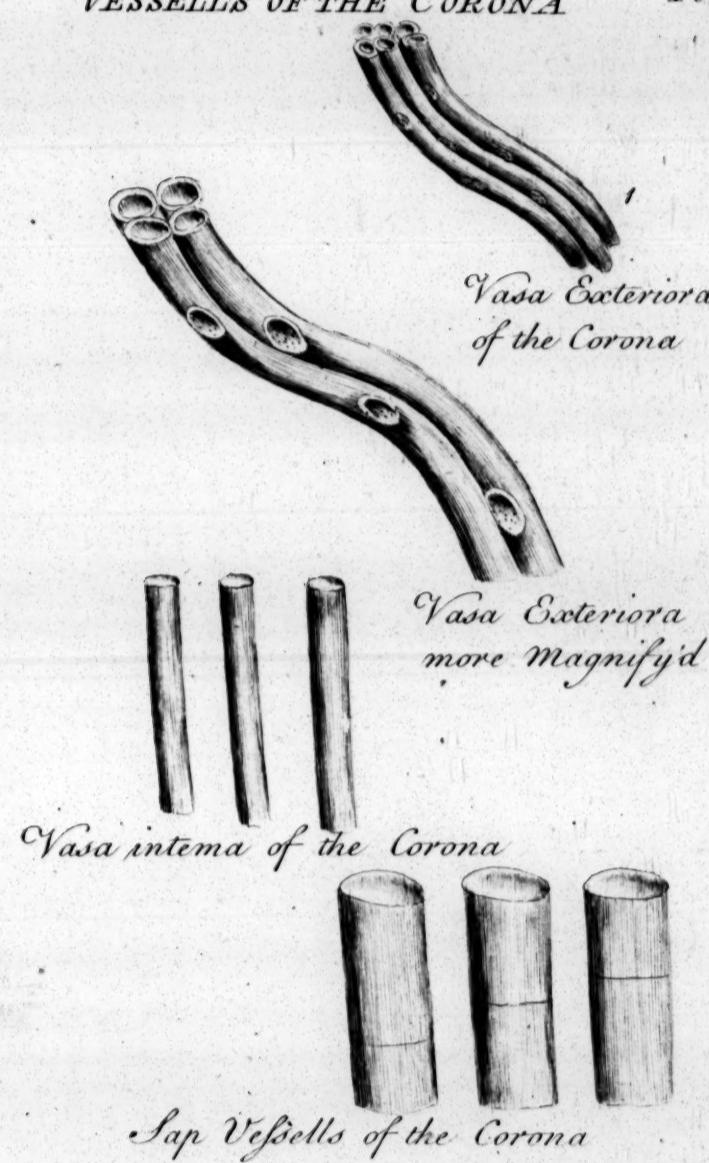
Pl. 14.



16

VESSELS OF THE CORONA

Pl. 15.



## C H A P. V.

## Of the VESSELS of the CORONA.

WE have seen what are the differences of Vessels in the Vegetable Structure; for PLATE we have already viewed all their kinds. The Corona is the whole in miniature: XV. it contains the embryo's of future Shoots; and therefore must contain their Vessels, and can contain no other.

We have seen that of the two parts whereof the Corona consists, the Ring, and the Clusters, the Ring is the same with the Bark; it therefore has the same Vessels. Their appearance indeed is only that of the same objects viewed with a less power: only in one point there is a manifest distinction. This is in those openings which a great magnifying power discovers in these Vessels. These are proportionably twice as big in the Bark Vessels of the Corona, as in those of the grown Branches: nor is it difficult, from what has been said of their use, to guess the reason. These Vessels are represented at Plate XV. Fig. 1.

As the Vessels of the Circle or Ring of the Corona differ in nothing essential from those of the Bark; neither do the Vessels of the Clusters differ more from those of the several parts of the grown Tree, of which they are the embryo's. It is often possible (I cannot indeed say it is always easy) to distinguish the Vasa intima in the outer and inner ends of each Cluster; among the Vessels of the Blea. These, as well as the Blea Vessels, are very difficultly viewed with any distinctness in this compact and crowded condition; wherein they stand in the Cluster: but what difference I have been able to see, in these lesser Blea Vessels, is, that they have fewer but larger mouths than in the Blea of grown Shoots; and that there is an utter want of the spongy interstitial matter which in that state keeps them separate and at a distance: and that the Vasa intima, the proper object of enquiry here, have thinner coats, and are not so perfectly cylindric.

In the central part of every Cluster we are to expect to find those vast Sap Vessels which feed the whole interior part of the Tree; nor are we disappointed: they are indeed yet larger in proportion here than we find them in the grown Branches; for 'tis here they have their greatest use: 'tis these alone that can supply the Shoot in its first pushing out from the Branch. It is to grow before it has communication with the outer air; and 'tis by these Vessels, which here are always full, tho' in other parts they are so only at particular seasons, that the growth of an angle of the Corona is to be supported and supplied in its egress into a Branch.

## B O O K III.

## Of the ENCREASE by GROWTH.

## C H A P. I.

## Of the GROWTH of BRANCHES.

PLATE XVI. **T**O know the parts of the Vegetable Construction, unless we have also from that knowledge learned something of their uses, were a vain and idle boast. The encrease of the Tree, the new and multiplied life that it receives from the growth of Branches, each capable of becoming an entire and separate Tree by only sticking it in the ground; is a matter of the first moment. The œconomy and encrease lie here; and the uses of men are supplied as well thus, as from seeds; and with the advantage of more expedition.

Since it is from an angle or part of the Corona the Branch naturally arises, 'tis in this place we may most naturally and usefully trace it. There have been mistakes about the nature and method of the growth of parts in Plants, as well as in relation to those parts themselves: but 'tis not the purpose here to point out the errors of others, but plainly to enquire the way to truth. It has been thought, nay it has been affirmed under the sanction of very reputable names, that the Pith is the first part in all growth, and that the others form themselves about to cloath it. Experiments have shewn 'tis otherwise; and the way to certainty in this enquiry is so plain, that 'tis impossible any one disposed to observation can mistake it.

The Pith is so far from being the original or first formed part, so far from giving origin to the rest, that they are always formed or pushed forth without it. The Pith begins to grow after the Branch has shot to some length, and ceases to be of use after a few months: nay in the end loses again its accidental being, the Branch remaining perfectly sound and healthy without it.

Any

Any Cluster in any part of the Corona, protruding itself onward and outward in the PLATE growing season, carries a part of the Circle out with it. This protrusion is naturally made in the bosom of a leaf, because the Bark and other parts are there weaker and moister. The Cluster itself is a perfect piece of the wood, and the Bark which follows it out in its progress, perfectly cloaths it. Thus is the first protrusion of the Shoot made: but all this while there is no Pith. There was none in the Cluster of the Corona, and all things yet appear unaltered in it; only for their covering. The continuation of growth is made by the extension of all the parts obliquely upwards: in the course of this extension they hollow themselves into a kind of cylinder, the form of the future Branch: and by this disposition a small vacancy is made in their center. This enlarges as they encrease; and as it enlarges it becomes filled by the exudation of those little bladders before-mentioned; which remain and constitute the Pith; fed from the inner coat of the wood, which already begins to form itself into a new Corona; and by its elasticity preserving, and enlarging that cavity it fills.

To follow this enquiry successfully, split a young Shoot of the Red Dog-Wood, or of the common Dog-Wood of our hedges, early in Spring. If the fissure be continued directly thro' the two opposite Buds in any part, there will be seen an angle of the Corona forcing itself out on each side, in order to make a pair of opposite Branches. Each protruding angle forces its way thro' the soft young Wood, not by tearing its Vessels, but gradually insinuating itself between them; and nothing can be plainer than that it is an entire Cluster which is thus thrust forward to become a Branch, but that it leaves a thick line of the Circle or Ring of the Corona behind it. This is very happily visible in the Red Dog-Wood of America; because the Circle of the Corona is at that season very green, and perfectly distinguished from the Wood, which is of a whitish hue, and from the Pith, which is of a pale brown. The Bud, pushing onward, leaves a kind of vacancy behind it, or between its ascending base and the line of the Corona: thro' this vacant space pass a multitude of vessels, which supply the ascending Bud with a great deal of nourishment from the line of the Corona, which is left behind it.

Here seems the great use of this line of the Corona in the œconomy of Nature: and in the path of knowledge it serves to establish, beyond doubt, the True History of the formation of that supposed original part, the Pith. The Cluster of the Corona, which is to be a Branch, communicates with every part of the parent Tree, except its Pith; but all communication with that is stopped by this circle: nor can there be any intercourse of juices between their Vessels and its Blebs. We see in the examination of the Cluster that it has no Pith of its own: we see by this line of the Corona it can have no communication with the Pith of the Tree; and 'tis not only impossible that this singular substance should pierce that Ring, and enter the Cluster, but our eyes shew a space, a vacancy, between them: a part of the Shoot, wherein there is no Pith; but in its place a course of Sap-Vessels; things perfectly distinct from it, in nature, form, and disposition: and this space, tho' it be proportionably greatest in the very young Bud, yet it remains long visible after the Branch is grown; nay, and in some kinds, does at length obtain a kind of coarse Pith for itself.

**PLATE** At Plate XVI. Fig. 1. is shewn a piece of a young Shoot of Dog-Wood, split thro' XVI. the two opposite Buds, to shew their nature. The part *a* is the remaining line of the Fig. 1. Corona; *b* is the space left by the ascending Bud; and *c* are the Vessels pervading it.

*a b c*

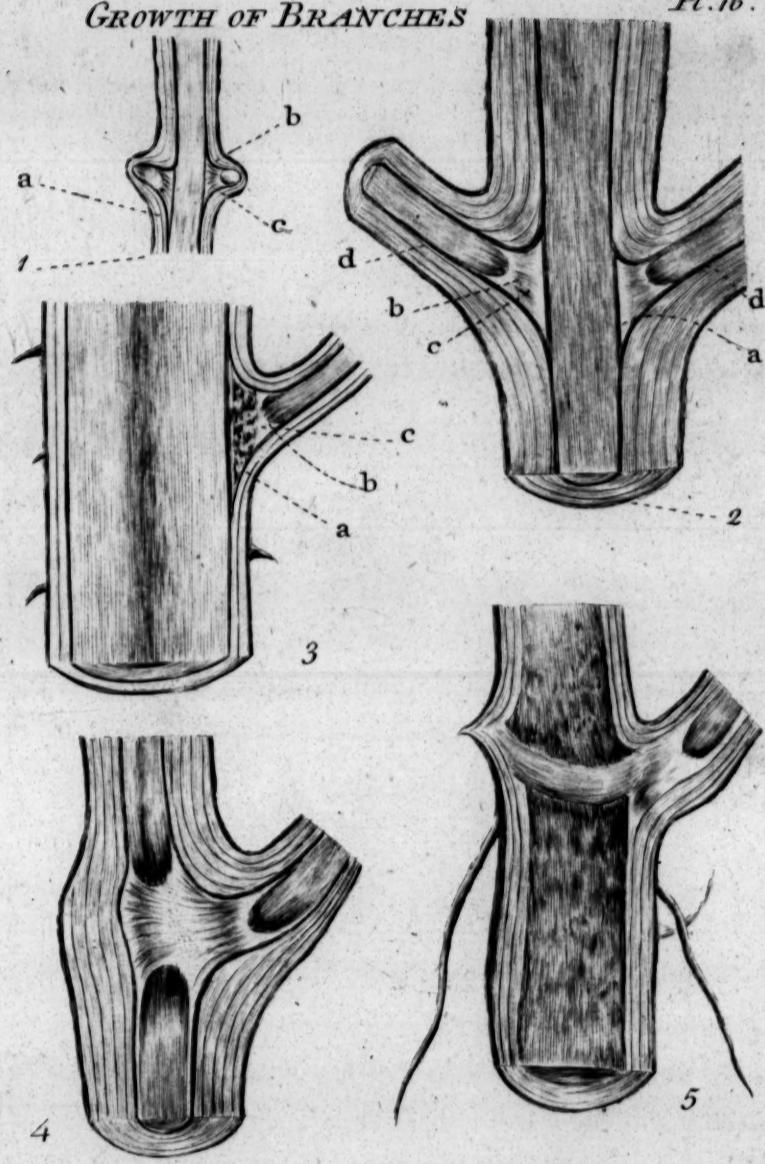
If now we take a thicker piece of the same Shrub, and instead of splitting it thro' two Buds we carry the knife thro' the stumps of two Branches, formed by two such Buds in some preceding season, we find the vestiges of every part remain. Such a piece is represented at Plate XVI. Fig. 2. Here we see the line of the Corona (letter *a*) still remain, but not supplied with any new Cluster: and hence we may learn that a second Branch can never rise from the spot, altho' the first should perish by any accident. At *b* the space still remains; and its Vessels *c* run thro' it: but as we carry our eye along the ascending Shoot, *d* we see at *d* a Pith in all respects the same with that in the center of the parent Branch. This Pith of the Shoot is not continued from the Pith of the Branch, as has been supposed; for they are not, nor ever were, continuous: there is, there always has been from the beginning, a space between them: the space existed even before the Pith of the Shoot was formed. This Pith therefore was neither derived from the parent Tree, nor original in the Shoot; but is a mere temporary and perishable production, excreted from the Shoot itself, and destined to serve its present purposes, and then to perish.

Let not the newness of this opinion make any one pause to receive it! Had we never had new opinions, old errors would have been immortal: but happily here we may refer not only to the Reason, but the Eyes! The shrub is before every one; a pen-knife makes the division; and scarce a common reading-glass is necessary to observe it.

Altho' in this Shrub the vacant space left by the ascending Cluster remains empty, it has been observed that there are some in which that very space itself becomes, after a time, filled with a sort of Pith. The Dog-Rose or Wild-Briar of our hedges gives an instance; and it is always happiest in these pursuits when the needful objects are the most familiar.

A Branch of this, with a Shoot rising from it, is represented at Fig. 3. In this the line of the Corona left behind is very distinctly visible at *a*; and the Pith of the Shoot at *b*; terminating, as is always the case, convexly towards the Branch. These two parts are very distinctly known by their green and brown colour; and in the original vacancy at *c* there is found a mass of a kind of Pith, very coarse in comparison of that either in the Branch or in the Shoot; and perfectly distinct from both, communicating with neither.

Fig. 4. In the Virginia Creeper, Fig. 4. the very Pith of the Stem is not continuous; but ends obtusely upward, and obtusely downward, as in the Branch. And in our own Vine it is not only discontinuous, but in the most perfect state of the Tree is intercepted, as Fig. 5. at Fig. 5.

*GROWTH OF BRANCHES**Pl. 16.*



## C H A P. II.

## Of the PROLONGATION of the SHOOT.

THE Prolongation of a Shoot already formed, is plainly a matter of more simple PLATE circumstance than the production of a new one: and here one would suppose the XVII. Pith, like the other parts, might be found continuous: but Nature, always consistent with herself, the God of Nature acting every where in the same amazing manner! confirms the doctrine of the separate formation of that in the Shoots, by its appearance, less expected here.—Be it suffered, Lord! to use thy name in honouring thy works.

The Prolongation of the Shoot in Trees is not a thing constantly and regularly going on; it has its seasons and its times; and takes its course more rapidly at some, more slowly at others: and there are some when it nearly ceases.

Let us follow its progress thro' a year; for the same is every year repeated: and tho' in various degrees of greater and of less, of swifter and of slower, it is the same in all.

In October, if we select a Shoot of the Ash-Maple, a quick growing Tree, we see its end terminated by a cone, composed of films. Here the growth of the past season has stopped. This cone is what we call a Bud; and thro' these films, at the ensuing Spring, the Prolongation of the Shoot is to be continued. Such a piece is represented at Plate XVII. Fig. 1.

Fig. 1.

In this state it remains thro' Winter: the cold having closed those pores thro' which the Root used to draw in the greater part of its nourishment. When the warmth of Spring returns, the Roots swell, these pores open; those vast cisterns the Sap Vessels of the Wood become filled, and every thing is nourished and begins to grow: the Shoot extends itself thro' its films, and seems a young Branch growing from or upon the old one. If we let it take its destined growth till May, 'twill then be in a condition to examine as to the nature of its growth, and the condition of its parts. Such a piece is shewn at Fig. 2. Fig. 2. entire; and at Fig. 3. split regularly open, and the fissure carried down into the Shoot of Fig. 3. the former season. What we see in it while entire is, that the top has been well covered with films; and there is an appearance as if the growth had come to an entire stop there: but in the split Shoot we see 'tis otherwise; there is a swelling at what was the top, *a a*; but the brown Bark and the white Wood, after thickening in their pause, are continued: they ascend just as the Cluster from the Branch, and leave like that a little space behind them, *e*.

L

In

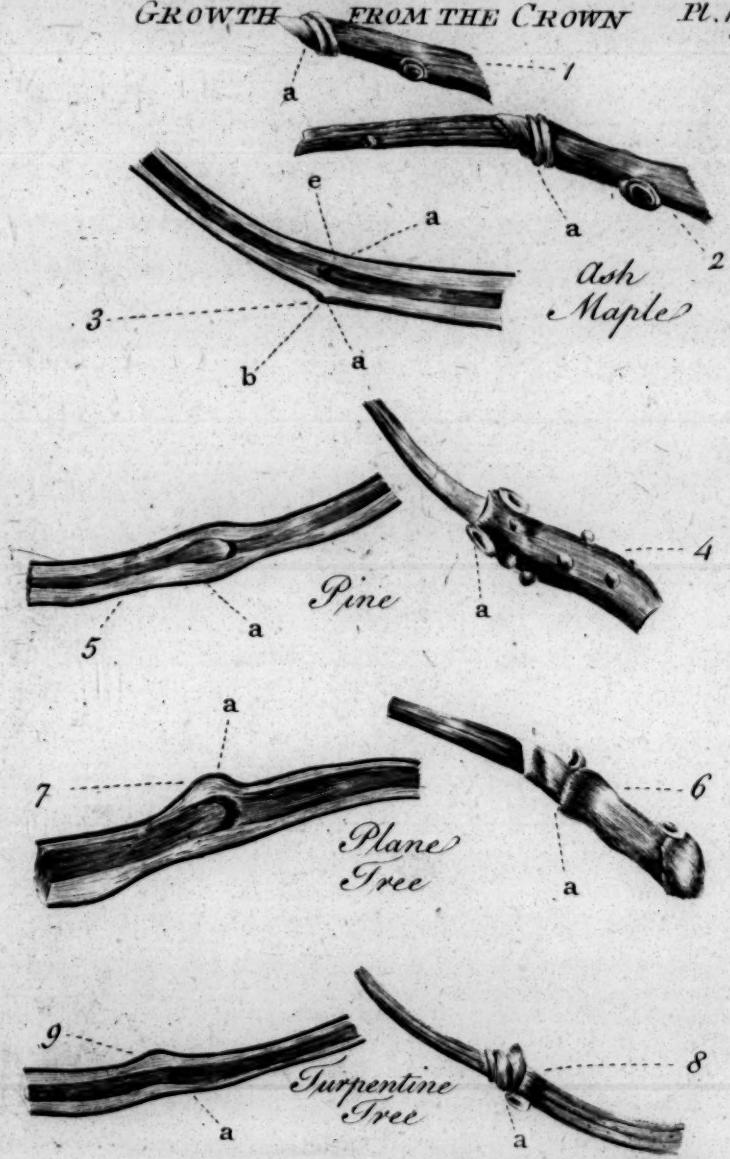
## THE CONSTRUCTION OF TIMBER

**PLATE XVII.** In the new growth all therefore is continuous except the Pith : the Vessels are only lengthened ; but the Pith has ceased. It comes to an absolute termination, in an obtuse form, as in the Fig. 3. *b b* other instances ; and after a space is left, Fig. 3. *b b*, a new Pith is generated in the ascending Shoot, the same in texture, form, and colour with that below : but, as has been just shewn in the other instances, perfectly disunited from it. The new Pith therefore is not a continued growth of the old ; but a substance ; produced, as that had been, from the other parts.

In this Maple the Pith has kept its cylindric form throughout, and not thickened at the Fig. 4. end with the swelling of the top of the Shoot. In the Pine, Fig. 4. where that swelling is greater, as it only affects the exterior parts, a greater space is left within than in the Fig. 5. former, Fig. 5. but if we split such a Shoot, we find 'tis not a vacancy that is left ; the Pith fills the larger hollow as fast as it is formed ; for 'tis only at the extension in length that its course ceases.

In the Plane Tree, where the disposition of the Pith is more irregular than in many other Fig. 6. *7. a* kinds, wherever the cavity extends, as at Fig. 6. and 7. *a.* the Pith always goes with it ; but still at the place where the Shoot of one season ceased ; and that of another begins, there *b* is a space between the Pith of the former, and that of the latter Shoot, *b.* And even in the Fig. 8. Turpentine Tree, Fig. 8. where this space is less than in any other which has come under Fig. 9. *a.* my observation, still it is a space, as at Fig. 9. *a.* and the Pith of the preceding Shoot ends in the usual obtuse manner, where the beginning of that of the young Shoot, altho' distinct, is yet irregular.

GROWTH FROM THE CROWN Pl. 17.





## B O O K IV.

## Of the different Disposition of the PARTS in various TREES.

## C H A P. I.

## Of Differences in the RIND.

THE strength of Trees depends upon the constitution of their essential parts: PLATE XVIII. the qualities of Trees rise principally upon their several added Vessels. The essential parts; the Rind, Bark, Blea, Wood, Corona, and Pith, are found in all Trees; tho' differently constructed and disposed: but the vascular parts, of this additional kind, are not only small and inconsiderable in many, but in some are entirely wanting: nor is it strange; for every Tree is not designed to be medicinal.

The general nature and usual disposition of these parts has been shewn in one instance, the Oak; in which they are all present, and where they lie in their most regular form: but in the variety of Trees which God has given for different purposes, there are so many variations from the general order of disposition and magnitude, that it is pleasant, in the light of curiosity, to examine them: but there are also higher purposes to be answered by such examination. Since it is to the construction of that part we call the Wood that Timber owes its strength; and to the size and contents of the Vasa propria all Trees owe their powers and virtues; an eye, thus accustomed to the visible differences, will guess almost to a certainty what strange Trees are worthy notice, as to durability; and what promise cures for sickness.

To lead to this distinctive method of viewing, it may be proper first to select one of the least complex of Trees or Shrubs; the simplest in its structure: since in such a one Nature will lay open many things in the ordering of the parts, which are hid in those of a more complicated texture.

## THE CONSTRUCTION OF TIMBER

**PLATE XVIII.** For this purpose, as one of the simplest of Shrubs, and one readiest at hand every where, the Dog-Rose may be selected: and there will be found in it, when examined fresh cut, and in the growing season, a distinction of colour in the several parts, which marks their outlines very happily.

If a piece of Dog-Rose be chosen which has finished the growth of one season; and has just begun that of another, (for in this quick growing Bush a Shoot acquires in that short time some considerable thickness) a section taken from this, of about the two hundredth part of an inch in thickness, will exhibit the parts with wonderful clearness. Where colour is useful, this degree of thickness answers better than those shavings which carry but a thousandth part of an inch.

A quarter, cut from such a section, and laid before the sixth glass of the Microscope, appears as at Plate XVIII.

We are to observe first, the Rind, which is, in this Shrub, very thick, and stands perfectly distinguished in such a perpendicular view from the Bark, by its colour: it is a narrow line of white, with small dots, which are the Vasa exteriora in it; *a b*. Within this we see a very broad circle, *c*; which is the Bark, very thick in this Shrub, and of a lively green. These parts can never appear in any instance more distinct. A little way within the inner line of the Rind, lodged in the substance of the Bark, appear the Vasa exteriora: these are of so strong a green, that their colour distinguishes them from the Bark as much as their form; *d*.

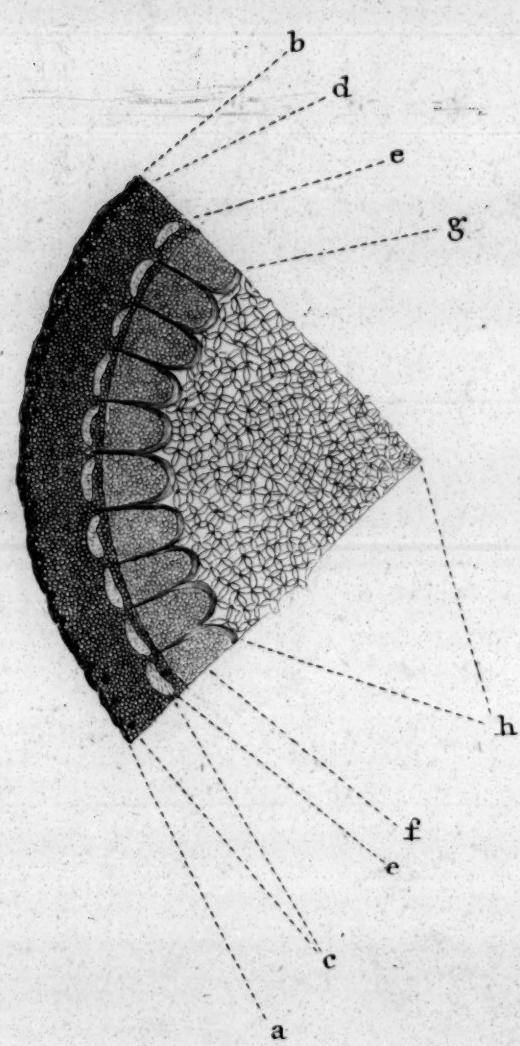
Within the substance of the Bark also, but toward its inner part, and very near the Wood, lies the Blea, *e*, perhaps better to be understood in this quick growing Shrub, taken at this season, than in any other kind. We see it, in most instances, a pale continuous line between the Bark and Wood; and such it will become, after a time, in this: but 'tis now in the state of its formation; and appears in several convex pieces palpably taking their origin from the Wood; and as yet disunited from one another. Its colour is a very pale olive, and its parts are very distinct. It is evidently now Wood, yet tender and but half formed, forcing its way into the Bark, which it will thrust out to the very edge hereafter. The regular green line of Bark, which separates this Blea from the Wood, broad as it now appears, will in half a year more be nothing but that slender line which separates and marks the growths of the several seasons.

Within this last mentioned green line we see the Wood of the Dog-Rose, *f*: even this is as yet composed of unconnected parts: and by this view of Wood in its infant state, and by no other, can we truly know what it is. It is now a white substance, in form of several ellipses, of a firm structure, and pale colour. Immediately within the bottoms of these ellipses we see the embryo Corona, *g*, consisting of a pale convex body, adapted to the ends of these ellipses, and formed by a separation of the two membranes of their parietes, or fides.

With

*Dog-Rose*

*Pl. 18.*





With what pleasure will the curious eye, having once acquainted itself with all these PLATE parts in their distinct and infant state, pursue them in other instances, where, in their XVIII. adult condition, they have united themselves for strength one with another, and often lost even the appearance of their original construction !

The Pith in the Dog-Rose is also a very beautiful object. It has, in a slice of this thickness, the appearance of starry forms, with oval rays : but this illusion vanishes on cutting a thinner slice. When one is viewed of a thousandth part of an inch they appear only simple Blebs.

---

## C H A P. II.

### Of Differences in the BARK.

THE Rind of Trees, being no more than an out-cast of the Bark, is of little PLATE importance to them ; and we find in it very little variation : but in respect of the XIX. Bark it is much otherwise. This is a very essential part in the Tree ; its growth depending, in a great measure, upon it ; and its qualities : and we find it accordingly very different, in substance, quantity, and nature, in various kinds.

It is originally the outer membrane, covering the Lobes of the Seed : even there it may be seen, just as in the Branch of a Tree, in form of a kind of sponge ; composed of flattened bladders : and in the succeeding growth, the outer ranges of these bladders, drying, become what we call the Rind ; for that part has no existence in the seed state : it is formed by the operation of the air ; it is stretched by the swelling of the Wood ; it is cast off once in a season, as snakes cast their skins : but not entire, only in fragments. Mean time the Bark remains what it was, covering the more substantial parts, the Blea, the Wood, and the rest, and feeding them by a continual supply of nourishment from its spungy substance, always supplied with water : this it draws up fresh as fast as it is drained off, and continually feeds every subjacent part. It protects all from external injuries also, and defends them from the effects of cold.

For these purposes it is variously disposed in different Trees. In the hardy and slow growing, as the Oak and Chestnut, it is thin : in the quick growing, as Willow, Poplar, and the like, it is thick : and, what is more worthy yet of regard, is, that altho' it is laid smoothly and in an even line over the Blea in most Trees, yet in some its inner verge is radiated.

## THE CONSTRUCTION OF TIMBER

**PLATE XIX.** There are some Trees, and a great many herbaceous Plants, in which this part is continued inward, in form of rays, thro' the Blea, into the Wood ; and seems to form so many green wedges, splitting as it were the substance of both those parts. It would be difficult to conceive how this were done, but that we have seen in the Dog-Rose these more solid parts are not originally compact ; but composed of separate pieces : between these the rays of the Bark insinuate themselves while they are open, and keep their places, tho' in a smaller compass, always afterwards.

The Sorbus Legitima, or true Service Tree, affords a very strong instance of this : a piece of a transverse section of this Tree is given at Plate XIX. This was cut from a Shoot in its fourth season : we see plainly at the lines of separation the growths of three perfect seasons : at *b* we see the act of growing in a fourth.

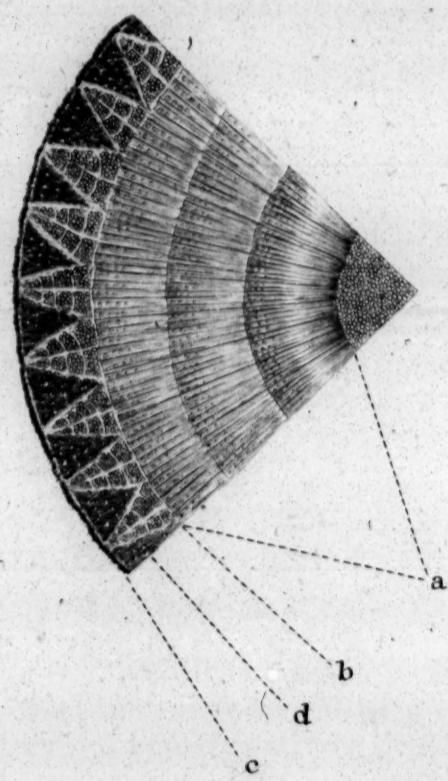
The Wood is here, as in the Dog-Rose, thrust forward and outward into the Bark ; *a* and that not in a continuous substance, as at *a*, but in detached bodies. They were *c* segments of ellipses in the Dog-Rose ; here they are cones. The brown Rind *c* terminates *d* their summits in a regular circle ; but the Bark *d* insinuates itself deeply among them, filling up all the space between cone and cone, to their very bases ; and thence continuing itself, tho' in a thinner line, thro' every season's growth of the Wood, down to the very Pith : marking out palpably, by its course, the several parts which once were cones of Blea ; as the exterior parts yet retaining the same form of cones, are the true Blea of the Sorbus now : tho' in the course of growth their taper ends have spread to the same breadth with their bases. Here therefore, as in the Dog-Rose, and some other instances, the Blea is always a discontinuous substance ; tho' in the generality of Trees it is one soft, but entire ring.

The use of this construction in the œconomy of Nature is not difficult to be understood : an object familiar to me, in infancy, first threw it upon my mind. In the park of Sir Francis St. John, at Thorp, near Peterborough, stood an old Service Tree, perfectly divested of its Bark, yet growing and full of vigour. I remember a thousand times climbing it when a boy, and to have heard wiser persons speak of it with wonder ; that a Tree thus naked could live. I did not, even at this time, understand how, till, taking a cutting from the garden of her Royal Highness, this structure presented itself to me. The coat of Bark could be spared, because there were rays of the same substance within ; which answered the purpose. Pursuing this subject I have also found that the Cistus Laurifolia, which has the same construction of rays from the Bark, lives very well when peeled ; and 'tis familiar that the Plane will do so. In that Tree also we see the same construction, and must no longer wonder at the same effect. There are many other Trees which have somewhat of this quality ; and in examining them I have found they have all some degree also of this construction ; and that, (so far as can be judged) a degree just answering to their more than usual quality of life.

That Leaves and Branches should be produced from a hollow Tree, whose Wood had perished, tho' the Bark was entire, could not appear wonderful to those who knew the nourishment was from the Bark ; but that a Tree could live whose Bark was gone, must seem, till this was known, almost a miracle.

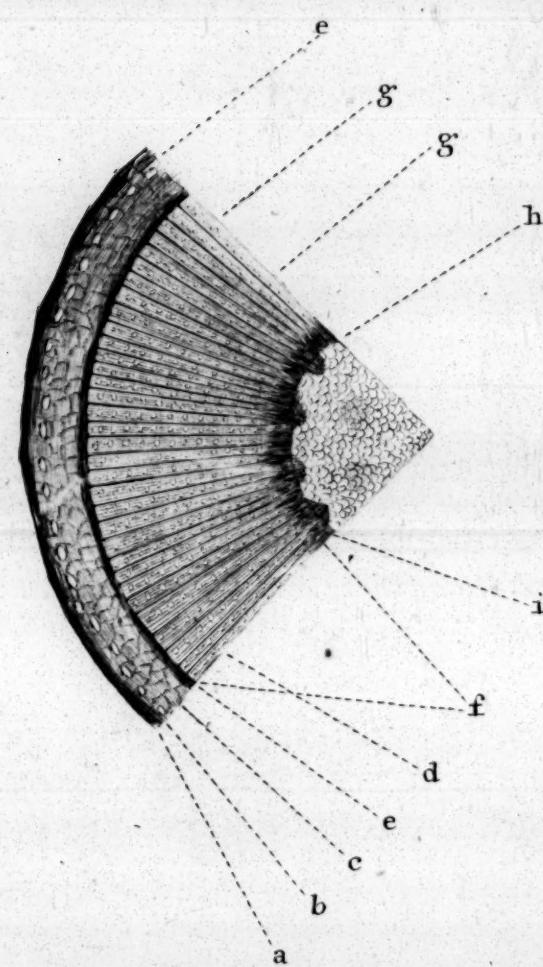
Pl. 19.

*SORBUS LEGITIMA*



Pl. 20.

*LIRIODENDRON LILIIFERUM*



## C H A P. III.

## Of Particularities in the BLEA.

THE construction of the Blea has been explained in its place : its disposition, and PLATE the arrangement of its parts, as they are various in different Trees, become now XX. the object of enquiry. The variations of Nature, in this case, are endless ; and there are scarce two genera wherein this and the other parts do not differ, more or less, either in their quantity, colour, disposition, or arrangement. From the great number of kinds which have passed under my eye on the present occasion, I shall select those where the differences or particularities are most considerable ; and be happy in pointing out to the attentive Reader what Trees, so far as this experience leads me, will best entertain his eye, and lead his thoughts to more enquiry.

## I. Of the plain Disposition of the BLEA in the LIRIODENDRON LILIIFERUM.

When we would see the Blea in its plain, most natural, and most simple state, that Tulip Tree which Botanical writers call Liriodendron Liliiferum affords a very fair occasion. A piece of this is represented at Plate XX.

Here the two Barks, *a b*, are very distinct ; the outer of a deep, the other of a paler brown : and between these and the white flesh *d* is placed at *c* a plain and even circle of the Blea. Its pale brown colour keeps it perfectly distinct from the Bark ; and its strong inner margin as plainly separates it from the Wood. This is the pure and perfect state of the Blea : and were it for the condition of this part alone the Tree would demand a place here : but it has been selected for more particularities than this. Nature is pregnant with wonder and delight ; and it has been the care, on these occasions, to chuse, among the number of those where the main object is equally perfect, such kinds as afford therewith most delight or most instruction, in the other parts. In this the Vasa interiora, *e*, are very beautifully placed just within the inner verge of the Bark : their oblong form is singular ; and the more so, as it is less regular and exact than in most cases. The delicacy of the Wood, *f*, and the arrangement of the Sap Vessels, *g*, in regular rays, are also worthy note ; and much more their regular diminution in size as they approach the Pith, *b*. 'Tis thus in all Trees, at a certain growth ; but scarce in any is so well seen, or takes place in the Shoot so early.

It

**PLATE XX.** It has been observed, in treating of the Corona, that the ring or circle of that part wherein the clusters of vessels are enclosed is of the nature of the Bark : this Tree gives *i* a plain proof of it at *i*.

## II. Of the warped Disposition of the BLEA in the NERIUM OLEANDER.

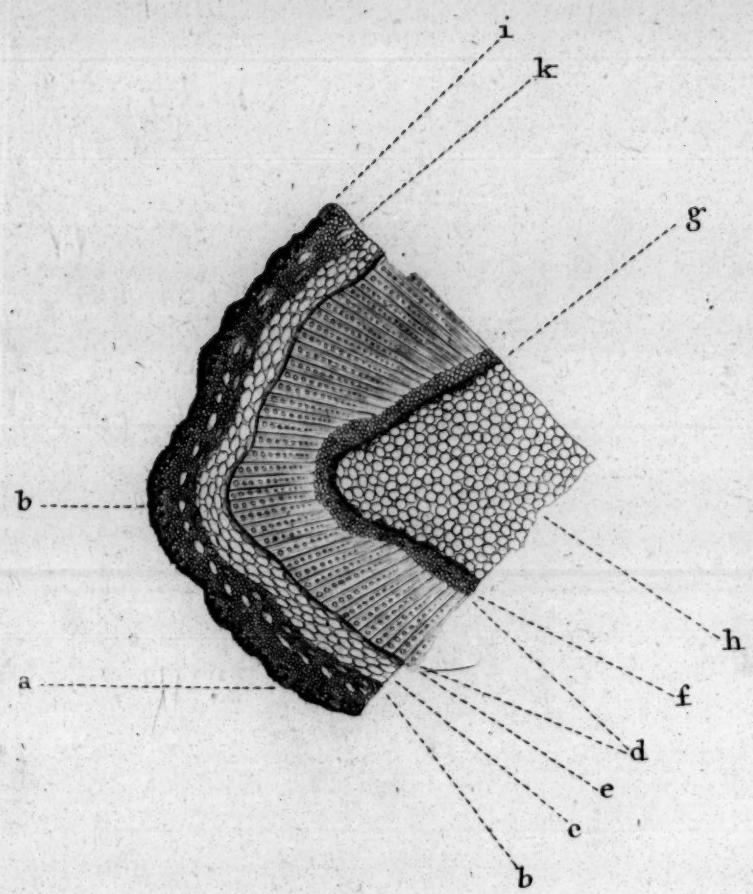
**PLATE XXI.** The Blea of Trees admits of variations from that plain and ordinary state wherein we have represented it before, both as to its disposition and construction : in some Trees one of these differences takes place ; in the other both. The form of the Shoots in the Oleander is not perfectly round, *a* ; and to this the Blea, as well as the other constituent parts, conforms itself. (See Plate XXI.) In shape it is not a circle, as in the Tulip Tree, but a swoln ellipsis, smaller at the ends, and rising on each part toward an angle in the middle ; and all this with great regularity, *b b*. Its texture is coarse, and its colour is a pale brown, *c*. The parts of which it is composed are the same as in all other Trees ; for one construction goes through all : but they are in this larger in their cavities, as well as thicker in their sides, than in others. The warped state of the line this Blea forms round the Wood, and the regular greatness of its parts, most claim our attention : but the object being before us, it were blindness not to remark also, that the Wood is delicately vascular, *d* ; that the line which is to mark the growth of another season is thicker than usual, *e* ; that the circle of the Corona is palpably of the same colour and substance of the Bark, *f*, and its clusters thrown together more than usual on the inner side, *g* ; that the Pith is *b i k* remarkably large, *b* ; and that the Vasa exteriora, *i*, and interiora, *k*, shew themselves with a distinctness very pleasing. There are two rings of the interiora very large and fair, and a perfect line of the exteriora, at the very verge of the Rind. What juice these last contain it has not been in my power to determine ; the former have a milky acrid matter in great abundance.

## III. Of the undulated Course of the BLEA in the NERIUM ZEYLANICUM.

**PLATE XXII.** Pursuing the construction of the Oleander in another species we see by what gradations Nature brings about her changes. The Blea in the Nerium Oleander was warped ; here it is undulated : there it ran out into four obtuse angles ; here it forms a multitude ; a continued series of them ; in this, as in the former instance, conforming itself to the shape of the young Shoot ; which in the Ceylon Oleander is neither perfectly round nor elliptic, but all the way raised in an uneven line, or in a kind of ridges and furrows. In the structure of this Blea we find a more considerable difference : it is a broad line of a pale whitish substance, formed of vessels with coats so remarkably thick, that Nature furnishes no instance equal to it ; (see Plate XXII. *a a*) and the spongy matter which fills their interstices is in like manner pressed close and compact. The colours also, in a fresh cut piece, afford a very good opportunity of marking all the constituent parts in this Shrub to a nicety ; and I hope it

Pl. 21.

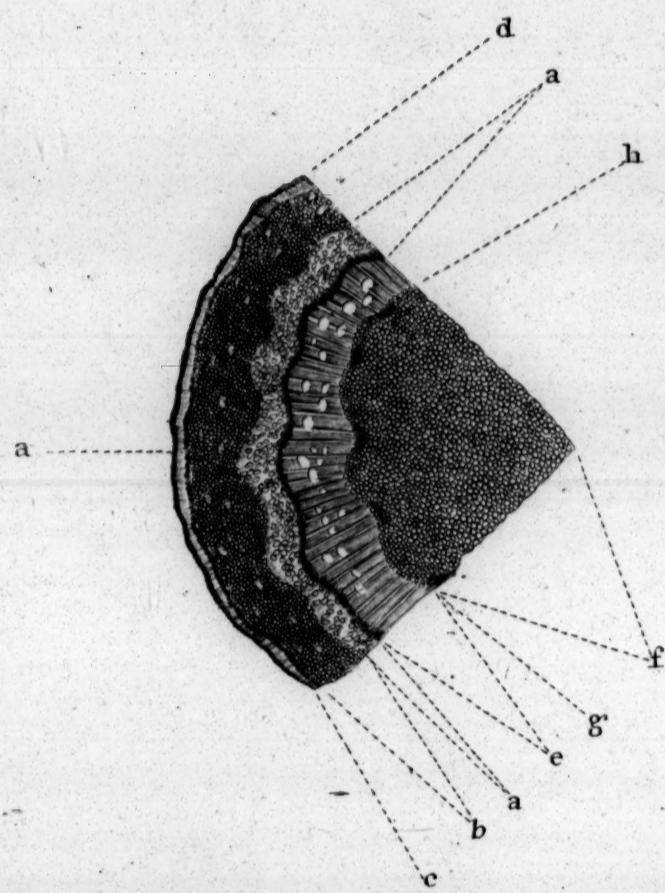
*NERIUM OLEANDER*





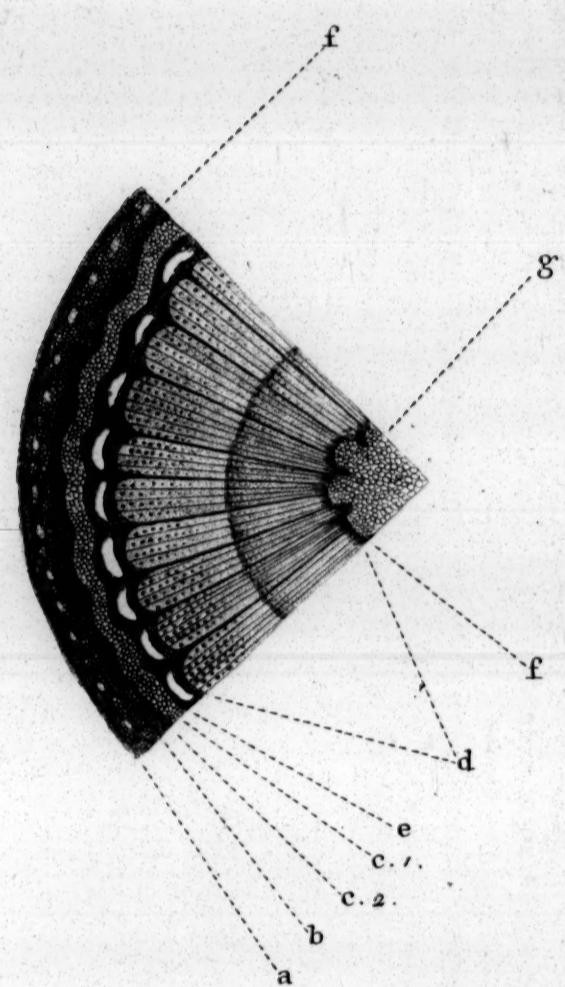
Pl. 22.

*NERIUM ZEYLANICUM*



*EPHEDRA DISTICHA*

Pl. 23.



## EXPLAINED BY THE MICROSCOPE.

47

it will therefore become familiar in the collections of the curious in Plants. The Rind is PLATE thicker than in most things, *b*; and the Bark of a very delicate texture: the Vasa exteriora XXII. are very numerous, tho' not so large as in many others; their quantity making amends for their want of size. Their disposition seems but irregular; yet a careful eye will count two ranges of them. The Wood has fewer Sap-Vessels than usual; and, what is much more strange, they are not perfectly round: the undulated outline of all the constituent parts perhaps presses upon them. The Pith is immense, and the Corona small: but Nature, consistent with herself, has given to the clusters of that undulated Ring the same disposition within the line, as in the common Oleander.

## IV. Of the difform BLEA of the EPHEDRA DISTICHA.

We have in this Shrub an instance of the sportings, as it were, of Nature, in the Blea; PLATE perfectly singular. It is considerable in quantity; it surrounds the Wood in that kind of XXIII. undulated line observed in the preceding instance; and to a correct observer it appears very distinctly to be of different textures in its different parts: a line of Vessels nearest the Wood, and a mere mass of confusion behind it, toward the Bark. This will not be difficultly understood by those who have first acquainted themselves with the composition of this part. We have seen it is constructed of vessels and an interstitial sponge. All that is singular here is that the sponge usually placed between vessel and vessel is kept separate, and thrown behind. A section of the Ephedra is given in Plate XXIII. and these two parts of the Blea are seen at *c 1. c 2.* But the Ephedra gives us much more *c 1. c 2.* matter of delight and wonder. With respect to its Rind and Bark, *a b*; and the disposition of the Vasa propria interiora, *f*; (for exteriora it has none:) they differ not from what is the usual course: but the Wood, *d*, which is delicately constructed, shews the diminution of Sap-Vessels toward the centre very distinctly: we even lose them toward the inner part of the last grown circle of the seasons. But beside this, that beautiful advance of the Wood toward another of those circles; that which charmed us in the Dog-Rose, raises raptures here. We see distinctly at *e* the pushing for a third circle of Wood; and here know how it is formed. The parietes of these frustums of cones, which in this object answer to the ellipses of Wood in the Dog-Rose, are extended in growth before the matter of the Wood is formed to fill them. It is palpable, in a good view of this kind, that they are well formed, but perfectly empty. The Corona is very beautifully hollowed; and in the Pith are palpable Vessels. This is the first occasion that has offered of naming them; but we shall see them in some other instances. They are the Vasa intima, so strangely disposed; this their structure shews, and the firmness of their contents. These pierce the Pith in a longitudinal direction; or more probably they are primordial in the structure of the Plant, and the Pith is formed around them.

N

C H A P.

## C H A P. IV.

## Of Particularities in the Wood.

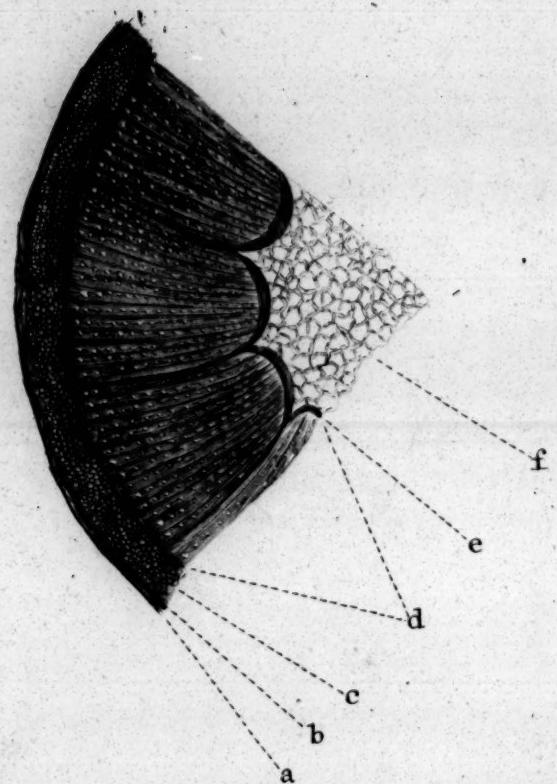
## I. Of its simple Structure in the Common Dog-Wood.

**PLATE XXIV.** **A** NEW thickness of Wood is given to a Shoot at every Spring and Midsummer; distinguished by a circle, marking the place where the former ended. The usual appearance of a section in this part is that of a multitude of rays, proceeding from the Blea toward the Pith; cut in many places by concentric circles; at different distances. But the number of parts confounds the eye; and to know what the Wood is, we are to seek it in some simple state. No instance affords this better than a section of a young Shoot of the common Dog-Wood. If we select one from a Branch that has had but one season for its growth, the appearance it gives before the Microscope is that figured at Plate XXIV. When we have cast an eye upon the Rind and Bark, and the broad circle *a b c d* of the Blea, *a b c*, we see the great, plain, and noble structure of the Wood at *d*; and find at *e*, what we had before seen in the Dog-Rose; that the Corona, howsoever afterwards it be filled, takes its original from the parietes, or sides of those obtuse broad cones which here are what the ellipses are in that other Shrub. And it is palpable that here in the Corona, just as in the protrusion for a second season's Wood, these parietes are the first part that grow. They form the space which there is to be filled with the matter of the Wood; and here, by a much more complex and wonderful substance.

The Wood is in this instance the most plain and simple thing imaginable; and its parts being naturally large, and not pressed together as in the harder kinds, can be viewed distinctly, and easily understood. We now see the Wood, which in old hard Trees we look on as one mass, is formed of cones, with bases tending outward, and each cone perfectly inclosed in a thick shell, of a matter more compact by far than the intermediate substance. Within these cones run multitudes of rays, all like the parietes of the cones, converging inward; and in reality each two of them forming a lesser cone, within the larger. Within this lesser cone, between these rays, is deposited the substance of the Wood, pierced with innumerable holes; or, in a more just way of speaking, giving place to a multitude of Vessels. These are the Sap-Vessels. The intermediate substance is the most compact part of the Tree: and this is always the real structure of that part; however it may in various instances seem to shew a wonderful variety. The Pith of the Dog-Wood, *f*, is, as the rest, the simplest we can look upon; a mere collection of hollow cells crowding and pressing upon one another.

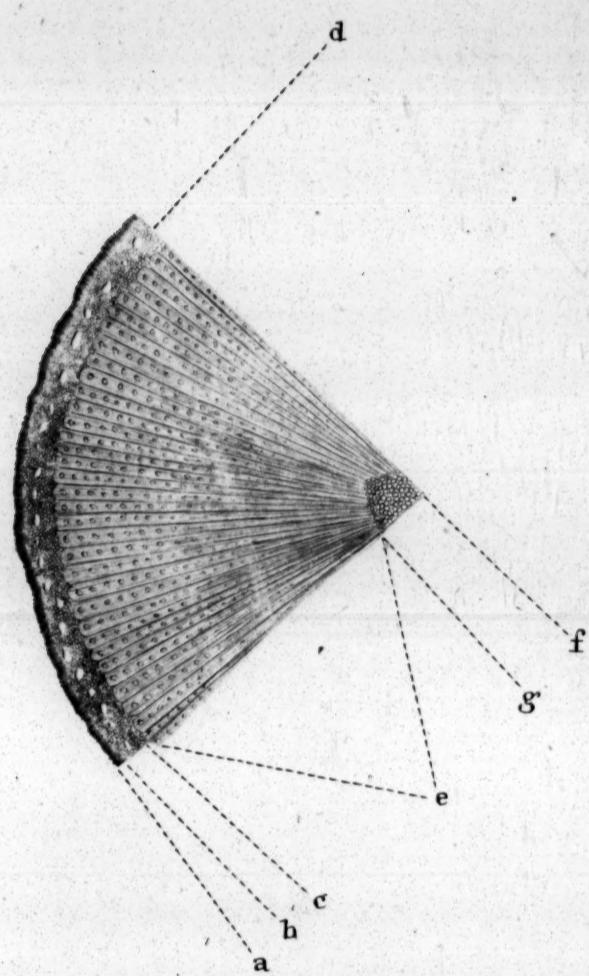
24  
*Pl. 24.*

*Dogwood*



*Pl. 25.*

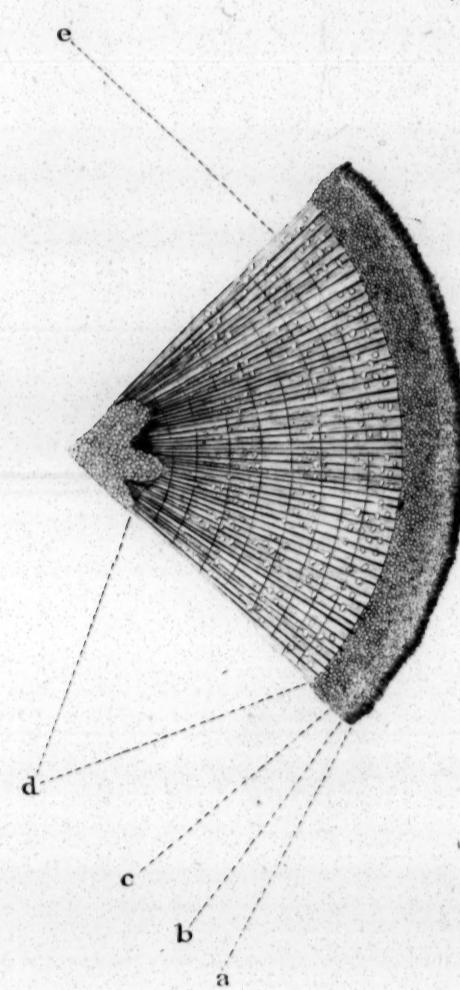
*ACACIA DECIDUA*





Pl. 26

*ROBINIA CARAGNA*



If this construction of the Wood, which is so easily understood in the present instance, be always held in mind, as we examine others, the secrets of the composition will be laid open to us with less pain.

## II. Of the Length of the Cones in the ACACIA DECIDUA.

A Tree which affords an instance of equal simplicity with the Dog-Wood, but in a PLATE new form, is the Acacia Decidua: a section of which is given at Plate XXV. yet the XXV. smallness, or, if it may be better understood, the delicacy of its parts renders it less obvious; and leads us, as by a single step, from that simple kind to the appearance of the more complex. The Rind in this Acacia is very thin; the Bark is also thin; *a b*: and in the Blea, which holds some breadth at *c*, are disposed Vessels so very much resembling the interiora of other Trees, that we should suppose them of the same nature, if we did not first see them in a place where the intima alone can stand; and if the firmness of the matter with which they are filled did not confirm it: but beyond all, their own structure: for they are simple Vessels; their sides are not vascular.

The Wood, which lies nearly within these, consists of very long and narrow cones. The parietes of these are extremely distinct, tho' fine; and the whole Wood is pierced with Sap-Vessels so large, that its own vascular structure, which is indeed in all Wood very delicate, gives the idea of a compact and solid substance. Nature, in this instance, giving all to the Wood, contracts the Pith, and half annihilates the Corona: 'tis very singular: but still the parts of that circle are to be seen in these young Shoots of the Acacia Decidua: and in those of more standing they become as large as usual. Why and to what end Nature, where nothing is done in vain, gives this exuberance of Wood to this, and the scanty store of it to Dog-Wood, are questions for a very high philosophy.

## III. Of the thick Parietes of the ROBINIA CARAGNA.

He who will join with me to pursue the last named plan; and try if it may be found PLATE why, in the Robinia now before us, the sides of those cases wherein the Wood is held XXVI. are remarkably thick, or, if we may use so strange a word, so coarse; will perhaps open the way to a knowledge of the nature of Trees; which, tho' propos'd more than two thousand years ago by Theophrastus, has passed thro' the hands of all his successors untouched, so far as their writings have informed us; therefore, at least, not happily followed.

The appearance of a section of this Tree is given in Plate XXVI. In the Rind and Bark, *a b*, nothing is particular. The Blea is very firm, compact, and delicate. In the Wood there are, as it were, shadows of circles; nothing real: but still we find the Sap-Vessels

## THE CONSTRUCTION OF TIMBER

Vessels disposed according to the same divisions. The great ribs which mark the separate cones are objects indeed of wonder; thick, firm, green, and strait as lines drawn from the circumference by a geometrician! It seems as if the effort of Nature in the construction and growth of this Tree had been placed here; and that these ribs had out-grown the division of the season circles. Those circles mark the stops of growth between the Spring and Midsummer encrease: it should appear that this Tree owned no distinction of those seasons; but that it continued equally at all times growing on. 'Tis singular in many things; in nothing more than this.

The Corona is small, but regular; and in the Pith are Vessels, stuffed, as the intima always are, with a concreted juice, like a hardened resin.

## IV. Of the broad Season Circles in the ARBUTUS.

**PLATE** The parts we wish to note in Trees for their singularity are best shewn by opposition.

**XXVII.** In the Robinia Caragna the circles of the seasons scarce exist: in the Arbutus, a Tree which few exceed in delicacy, they are yet remarkably conspicuous. A view of this is

*a b c* given in Plate XXVII. In the Rind, the Bark, and the Blea, *a, b, c*, nothing is particular; but in the whole construction of the Wood there is a delicacy which fancy scarce can reach. There is much more: there is a disposition of the Sap-Vessels strange and unusual; they are largest toward the base of every circle, and become obliterated gradually to the verges.

*f* In the common course it is quite otherwise: but the line *f*, the mark of distinction between the encrease of a former and a latter season, is, in the Arbutus, thickened beyond what we see in most kinds: and even the exterior part of the first circle from the Corona is thickened with it. The Corona, *e*, partakes of the delicacy of the whole structure of this beautiful species; and, tho' small and thin, and more than in most other kinds transparent, affords a view of all its constituent parts very perfect, and very lovely.

## V. Of the uneven Lines in the Wood of the THUYA CHINENSIS.

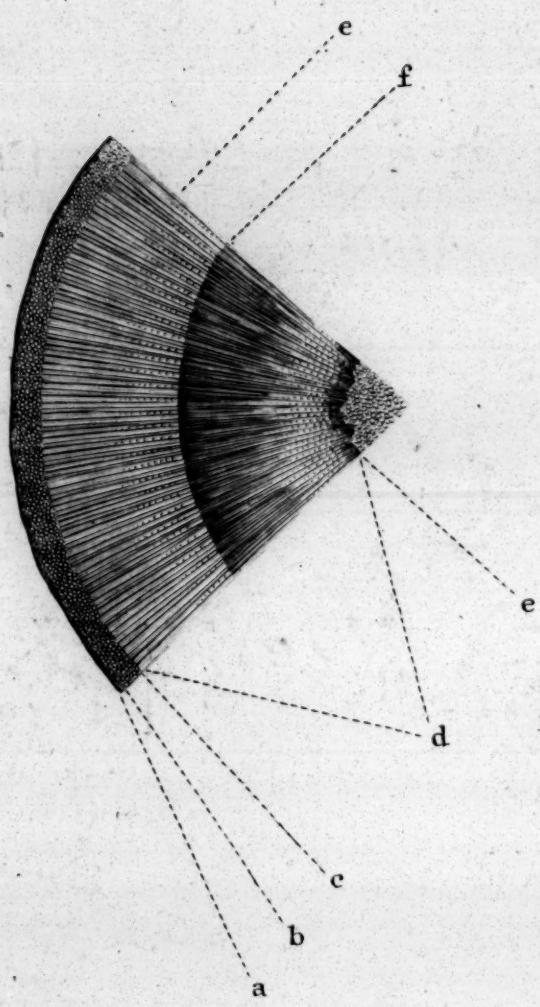
**PLATE** Our attention was demanded, in a preceding instance, by the perfect regularity in which

**XXVIII.** the lines formed by the parietes and inner divisions of the Wood were drawn from the circumference to the center, even with a mathematical exactness: we have here a proof how much Nature can deviate from what might seem her destined rules; yet without altering the construction of those portions with the disposition of whose component parts she wantons. A section of the Thuya Chinensis, the China Arbor Vitæ, is one of the most delicate objects that can be placed before the eye: in this manner 'tis represented at Plate XXVIII. The rays or lines which divide the Wood into innumerable smaller cones are here thrown into an easy wave, which, taking its rise from the inner line of the Blea, bends downward in the new circle, then rising in the second and third, takes again its first course in the innermost; and this with an easy bend that is very pleasing. All the

time

Pl. 27.

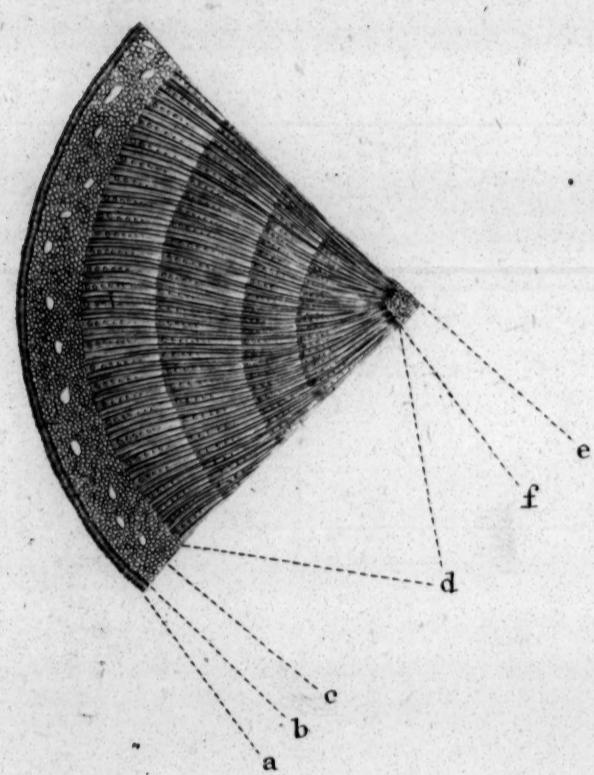
*ARBUTUS*





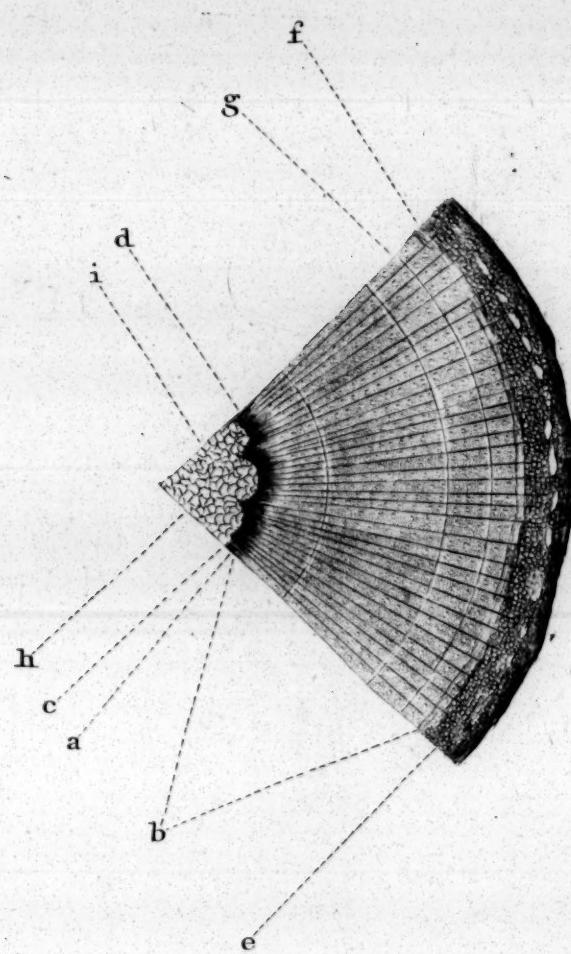
Pl. 28

*THUYA CHINENSIS*



Pl. 29

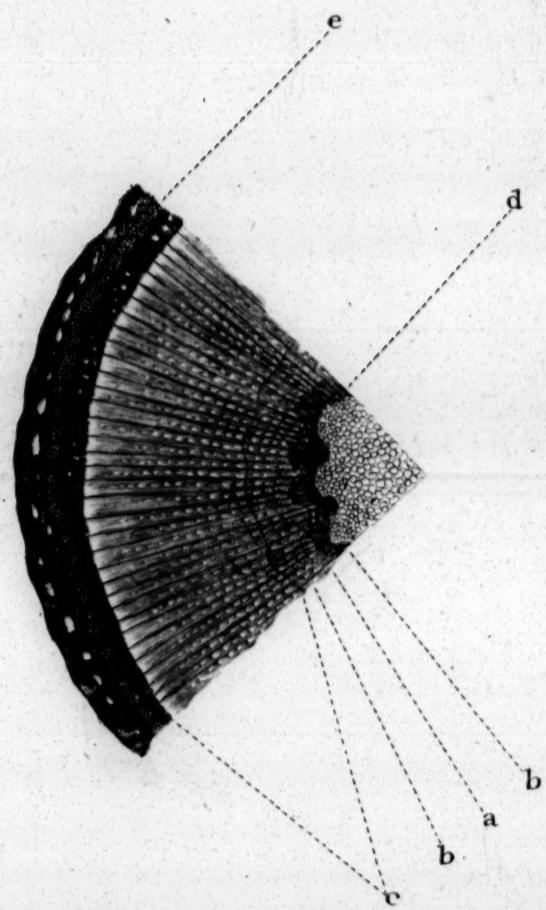
*CISTUS LAURIFOLIA*





*MAGNOLIA GLAUCA*

No. 30.



## EXPLAINED BY THE MICROSCOPE.

51

time the parts are as distinct, and their quantities and proportions are as regularly kept; and as well observed, as if the lines had run with the most perfect straitness. For the rest, what is observable in this fine Tree, is, that the Pith is extremely small; the Corona very delicate, but finely formed, and it runs into deeper angles than is usually seen: the Sap-Vessels of the Wood are largest in the youngest parts of it; and the Vasa propria exteriora are very distinct.

---

## C H A P. V.

### Of Particularities in the CORONA of TREES.

#### I. Its Plainness in the CISTUS LAURIFOLIA.

THERE can be no doubt but the construction of this essential part is perfectly the PLATE same in all Trees: the strictest observations, and the powers of the greatest glasses, XXIX. join to shew this: but here, as in the Wood, and elsewhere, altho' the parts are invariably the same, their disposition differs wonderfully. In the Cistus Laurifolia, Plate XXIX. the Corona is little more than a plain ring, *a*: in which, however, we see easily the simple structure of the Bark in the outer part, *b*, unmixed with other matter. In the portion next the Pith, that darker line it first exhibits, *c*, shews, when viewed with due advantage, the clusters, *d*, on which all future encrease depends. For the rest, the coarse form of the Blea, *e*, is singular in this Shrub; as is also the thickness of that line which terminates the Wood toward the Blea, *f*. The Sap-Vessels, *g*, in the Wood itself are small, but finely disposed; and in the Pith, *h*, there are some clusters of the Vasa intima, *i*, whose contents are less compact than those vessels usually have them.

#### II. Of the Exterior Prominence of the Clusters in the MAGNOLIA GLAUCA.

The Corona in this beautiful Tree does not carry the simple outline of the Cistus: PLATE its clusters are not buried in its substance. The whole of the Corona of this Tree, a section XXX. of which is given in Plate XXX. is of an undulated form, *a*; and its wavy prominences, *b*, which are but small toward the Pith, swell out into the form of obtuse and

O

unequal

## THE CONSTRUCTION OF TIMBER

PLATE unequal cones toward the Wood, *c*; whose firm texture gives way to them, and leaves them XXX. their appointed figure. Into each of these prominences is carried one distinct and perfect *c d* cluster, *d*, wherein all the parts are very visible, and the Vessels of the different orders are most distinctly seen. The view here given was taken with one of those wonderful glasses made by the Pere de Torre, placed in the apparatus of the double Microscope, instead of the tube. Nothing could shew an object more distinctly; and the reverend father deserves the highest praise; whatever fate prevented his receiving it from our Royal Society: whatever blindness or malevolence there, injured his fair fame.

What is observable farther in this noble object is, that the Blea, *e*, has in it a regular and connected chain of vast vessels, perhaps exceeding the Vasa intima in any other Tree; and that behind these, in their proper place, the substance of the Bark, there is also a regular course of very large Vasa propria interiora. These promise virtues in the Tree; for they contain thick juices: but they are yet unknown.

### III. Of the Interior Prominence of the Clusters of the CORONA in the STAPHYLÆA.

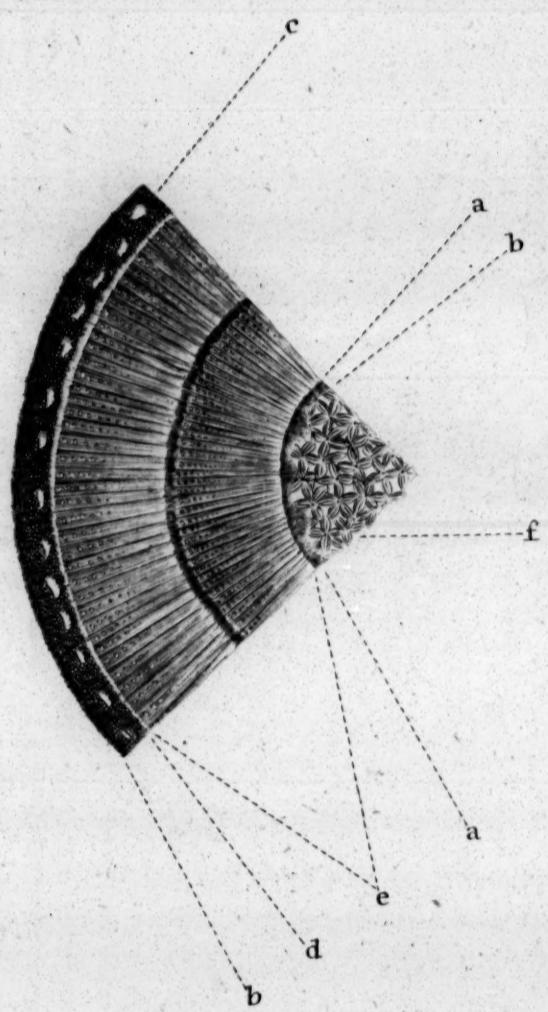
PLATE The common Bladder-Nut, Plate XXXI. affords the Microscope, in this way, an object XXXI. of great beauty; and, in the construction of the Corona, *a*, the part here under immediate *a* consideration; it is of proper singularity also to follow, in the mind's eye, that of the Magnolia. That circle here rises, as there, into protuberances, in form of obtuse cones: but, as in that Tree, there they are thrust outward into the Wood; here they project inward, and *a b* form an indented line about the Pith, *a b*. Each of these protuberances, as in that instance, contains one of those clusters from which the encrease of the Tree is made by new Branches.

*b* The Bark in this Tree also is delicately constructed, *b*; and in it are a series of very *c d* beautiful Vasa interiora, *c*. The Blea, *d*, is almost nothing; a mere white line separating *e f* the Wood from the Bark. The Wood, *e*, is delicate; and the Pith, *f*, being formed of shallower Blebs than in many other kinds, affords a very pleasing mixture of double, treble, and quadruple lines; in various figures.

### IV. Of the Projection inward of the Clusters in the PLUKNETIA VOLUBILIS, in Form of Cylinders.

PLATE The undulated line, with the protrusion of its risings into a kind of cones, is not the XXXII. highest effort we see in Nature, under this head. The Pluknetia, Plate XXXII. affords us an instance where those protuberances, every one of which is as it were the coat or shell *of*

Pl. 31.

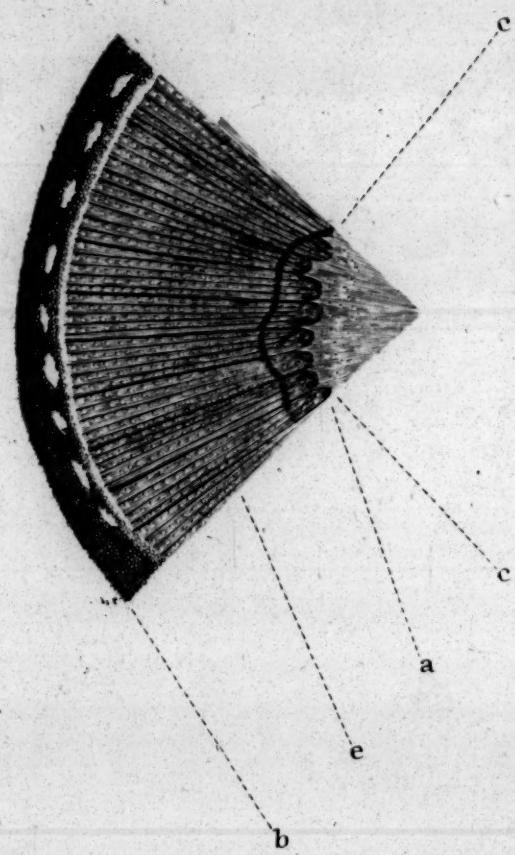
*STAPHYLÆA*

)



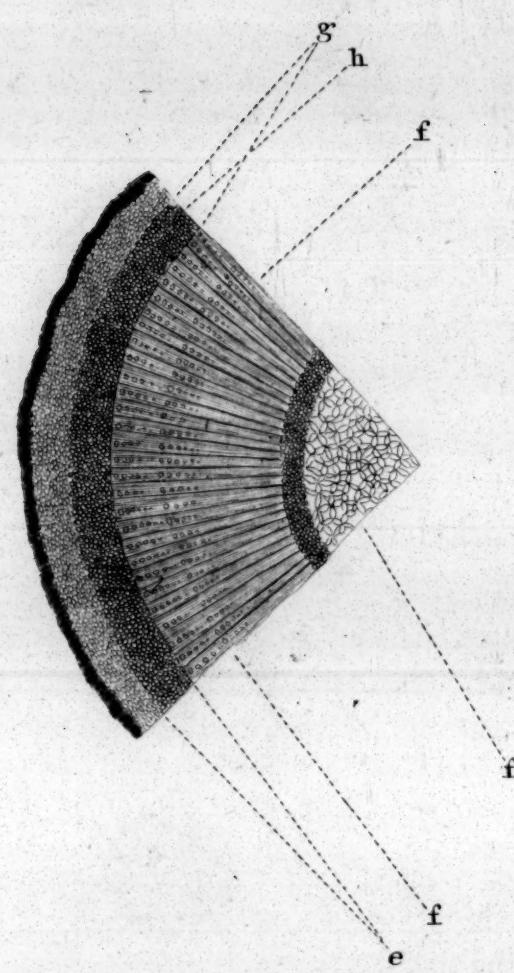
Pl. 32.

*PLUCKNETIA VOLUBILIS*



*Pl. 33.*

*ANNONA SQUAMMOS*



of a cluster of propagation, form themselves into absolute cylinders; and seem continuations of the parietes of the cones of Wood, making at least the outline of those cases. The circle, *a*, of the Corona here is plain and perfect Bark; no way to be distinguished from that at *b* but by the smallness of its parts: but the protuberances, *c c*, altho' they carry *b* *c c* the same kind of outline with the Wood, *d*, are perfectly different in their contents. *d*

It has been observed before, that the outline of the Corona is always first formed by a duplicature of the sides of the Wood cones; and what we see in this instance is an evidence of that conformation, the traces of which remain longer in the Oriental lane than in most other Trees. The construction of this Tree does not in any thing else material differ from the usual course, unless it be in a superior degree of regularity and distinctness of lines; *e*.

## C H A P. VI.

## Of Particularities in the PITH.

## I. Its plain State in the ANNONA SQUAMOSA.

THE Pith lying immediately within the Corona must in all cases take its form from PLATE the interior outline of that part; for 'tis too soft to have given the figure to the XXXIII. Corona, not to say that it is always postnate, and was not in being when that line was formed. In the Annona, Plate XXXIII. we see it in what may be called its simplest and most natural state. It fills a regular circle exactly in the center of the Branch, and has neither protuberance nor indenting, *f*; and it affords all that delight to the eye in viewing, that a Pith is capable to give; for its cells are very shallow, and the films that form them very delicate; so that in viewing a piece of about an hundredth part of an inch in thickness, such as is represented here, we see thro' a vast multitude of them at once, whose outlines intersecting one another give cobweb-like stars, and forms, of great variety and beauty.

For the rest, the Annona is no trifling object. Its Blea, *e*, is greater in quantity and more distinctly formed than almost in any other Tree. The Wood is regularly disposed, and pierced by numerous Sap-Vessels, *f*: and in the substance of the Blea, *g*, are Vasa *f g* intima, *b*, greater than in many other kinds. *b*

## II. Of

## II. Of the Pentangular Form of the PITH in the ALMOND.

**PLATE XXXIII.** We need not always search the stoves for Trees or Shrubs to afford delight in this examination; our gardens, nay in many instances the hedges, afford them. If elegance of structure alone were sought, and beauty were the object in pursuit, scarce any kind affords it in a degree beyond the Almond. But beside this, it has also great singularity, and is in many parts most worthy of observation. Plate XXXIII.

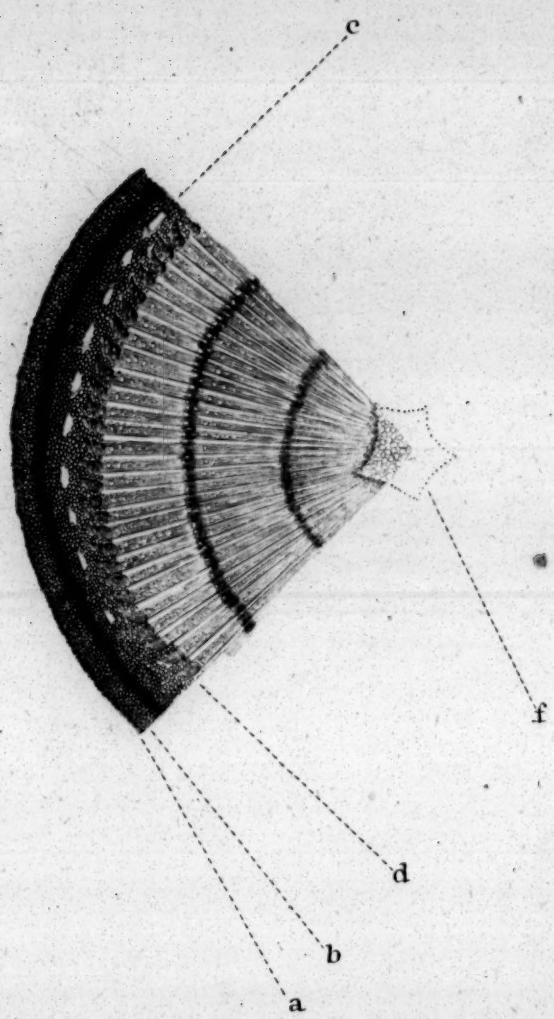
In most Trees the Pith, conforming itself to that of the other coats, takes the same shape with the outline of the Twig. 'Tis round we have seen in the Annona, and in the Oleander 'tis elliptic, and angulated; in each case, answering to the shape of the Shoot: *f* but tho' the Twig of an Almond Tree be round, the Pith is pentangular; *f*. This form is given it by the Corona; which, tho' extremely narrow, yet preserves that shape with the most trim exactness. The Pith answers in delicacy to the Corona; tender, thin, transparent, and very prettily figured. But in the Almond there is more worth notice: *a b* the two Barks, *a* and *b*, are thicker than is usual; and in the substance of the latter lie *d* oval Vasa interiora of great note. The Blea, *d*, is formed of little cones turned toward the sun, and between these runs in a quantity of Bark, separating also for a little way the cones of Wood. The Almond should therefore be in Nature another instance of a Tree that may survive when peeled; and what it may be, that it is: many Almond Trees at Denham shew it. The Wood in the Almond is delicate; but as the Barks are thick, so are the lines which divide the circles of the seasons.

## III. Of the PITH of the PETRÆA CONIFERA, not Central.

**PLATE XXXIV.** The sportings and the wantonesses of Nature, if such expressions may be used on unoffending subjects, have been spoken of. Doubtless what vain philosophy has taught us to call by the idle name Lusus Naturæ are things referable to causes that would exclude the term, if they were known. But howsoever that may be, the Petræa Conifera, Plate XXXIV. gives a very striking instance of this kind. One would suppose, if any thing could be called certain about the Pith, it would be its central disposition: at least it might be thought so in respect of young Branches; for they have not been in the way of those accidents which might have thickened one side of a Trunk at the expence of another: but here we see that great disposer placing, even in the youngest Shoots, the Pith far on one side of the Bough, *a*. The Petræa affords us also an instance of one of the simplest Piths, surrounded by a Corona as little considerable as any other: but in the Wood of this Tree, *b*, there is as much singularity of construction as of the Pith in place. That part is formed of very broad, very obtuse cones, whose parietes take that wave so delicate in the Thuya Chinensis; and consequently the interior lines have also the same turn. This adds not a little to the prettiness

*Pl. 33*

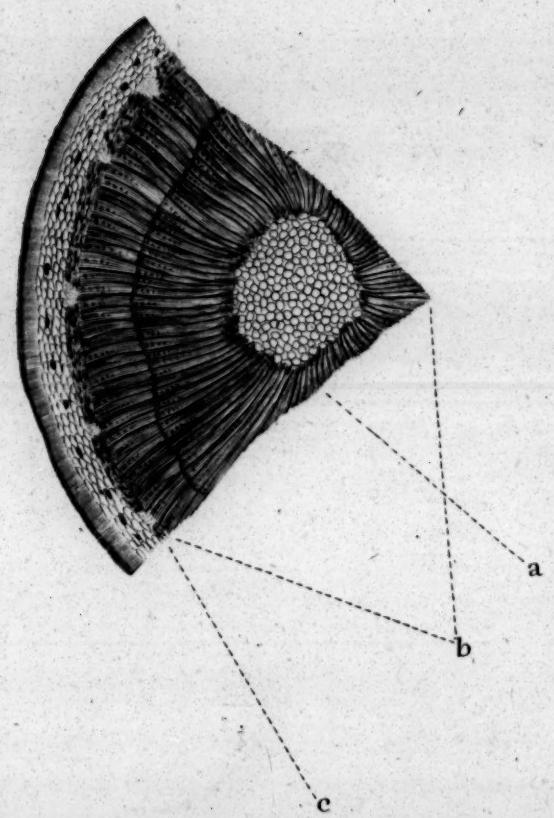
*ALMOND*





*Pl. 34.*

*PETRAEA CONIFERA*





prettiness of the object, when a section of the Tree is viewed: but there is more to be PLATE observed on this head: the Blea, *c*, is very considerable in quantity, and pierces the Wood XXXIV. between the greater cones; just in the way the Bark has been shewn to do in many Trees. *c*  
It were well if this species were more common, that we might see whether or not the Blea could serve the purpose of the Bark in its growth; for here, as the Bark is perfectly separated from the Wood, if on the peeling a Branch of *Petræa* it still continued to grow, we should know the Blea can serve the office of the Bark, as well as that which is immediately its own.



prettiness of the object, when a section of the Tree is viewed: but there is more to be PLATE observed on this head: the Blea, *c*, is very considerable in quantity, and pierces the Wood XXXIV. between the greater cones; just in the way the Bark has been shewn to do in many Trees. *c*  
It were well if this species were more common, that we might see whether or not the Blea could serve the purpose of the Bark in its growth; for here, as the Bark is perfectly separated from the Wood, if on the peeling a Branch of Petraea it still continued to grow, we should know the Blea can serve the office of the Bark, as well as that which is immediately its own.

## B O O K V.

## Of Particularities in the VESSELS of TREES.

## C H A P. I.

## Particularities in the VASA PROPRIA EXTERIORA.

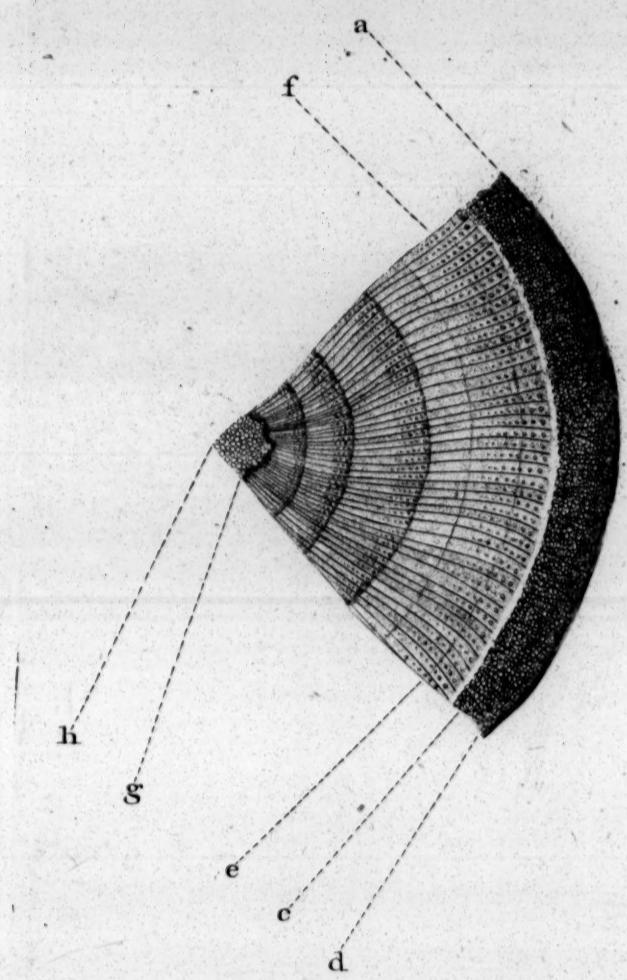
PLATE XXXV. **T**HIS is no part of the Vegetable Construction so little liable to variation, as far as I have yet seen, as this of the Vasa propria. Their form and disposition in the Oak has been given already; and that is in almost every Tree the true state of their arrangement. They are often too small to be very observable: the eye frequently misses them, unless assisted by some new power of glasses; and when it finds them, they are just what they were in kinds that offered them more easily to the view: only in the American Cypress, represented at Plate XXXV. I have seen a difference: and 'tis there indeed a great one. In other instances they are packets of little Vessels; tender, thin in the coat, and filled with some tough juice. In this Tree they are single, *a*, their coats are firm, they rise up above the surface of the rest of the parts when the section has lain a little while, (that is, they contract less than the other parts, which therefore recede from them,) and they are more than filled; (at least 'twas so at the season, April 17. when I examined them) they run over with a most pure and perfect balsam, and shew their sides, tho' thick, unable to resist the force with which this has been thrown up into them: for they appear burst in many places.

*c* For the rest, this Tree is not without its particularities. The Blea, *c*, rises in cones; *d* and the Bark, *d*, forces itself between them; but does not penetrate the Wood, as in some *e f* other instances. The texture of the Wood, *e*, is very delicate, and the Sap-Vessels, *f*, are *g* numerous, but not large. The Corona, *g*, in this Tree is small, but very correctly defined; *b* and the Pith, *b*, is extremely thin.

C H A P.

Pl. 35

*AMERICAN CYPRESS*



## B O O K V.

## Of Particularities in the VESSELS of TREES.

---

C H A P. I.

## Particularities in the VASA PROPRIA EXTERIORA.

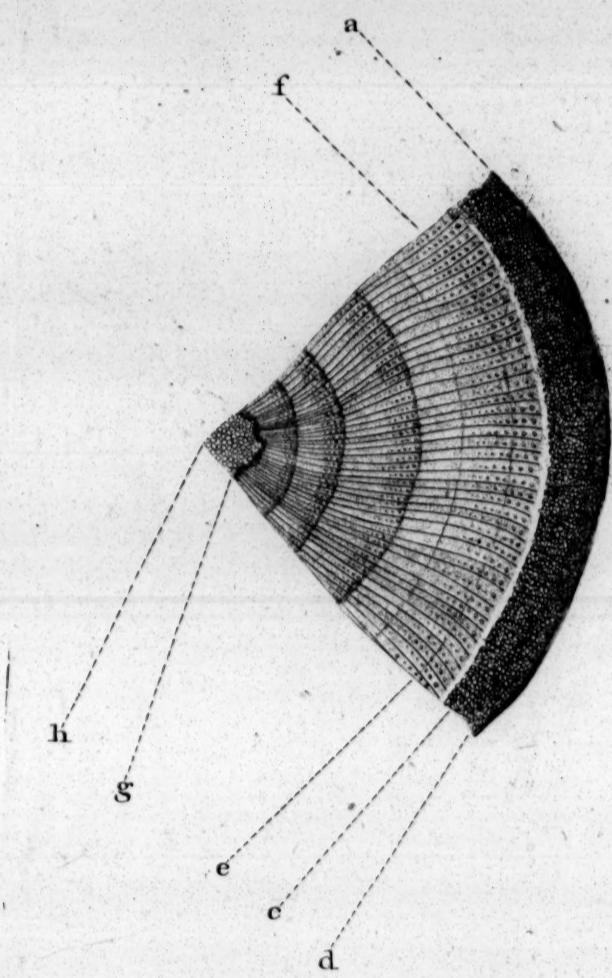
PLATE XXXV. **T**HERE is no part of the Vegetable Construction so little liable to variation, as far as **a** **I** have yet seen, as this of the Vasa propria. Their form and disposition in the Oak has been given already ; and that is in almost every Tree the true state of their arrangement. They are often too small to be very observable : the eye frequently misses them, unless assisted by some new power of glasses ; and when it finds them, they are just what they were in kinds that offered them more easily to the view : only in the American Cypress, represented at Plate XXXV. I have seen a difference : and 'tis there indeed a great one. In other instances they are packets of little Vessels ; tender, thin in the coat, and filled with some tough juice. In this Tree they are single, **a**, their coats are firm, they rise up above the surface of the rest of the parts when the section has lain a little while, (that is, they contract less than the other parts, which therefore recede from them,) and they are more than filled ; (at least 'twas so at the season, April 17. when I examined them) they run over with a most pure and perfect balsam, and shew their sides, tho' thick, unable to resist the force with which this has been thrown up into them : for they appear burst in many places.

**c** For the rest, this Tree is not without its particularities. The Blea, **c**, rises in cones ;  
**d** and the Bark, **d**, forces itself between them ; but does not penetrate the Wood, as in some  
**e f** other instances. The texture of the Wood, **e**, is very delicate, and the Sap-Vessels, **f**, are  
**g** numerous, but not large. The Corona, **g**, in this Tree is small, but very correctly defined ;  
**b** and the Pith, **b**, is extremely thin.

C H A P.

Pl. 35

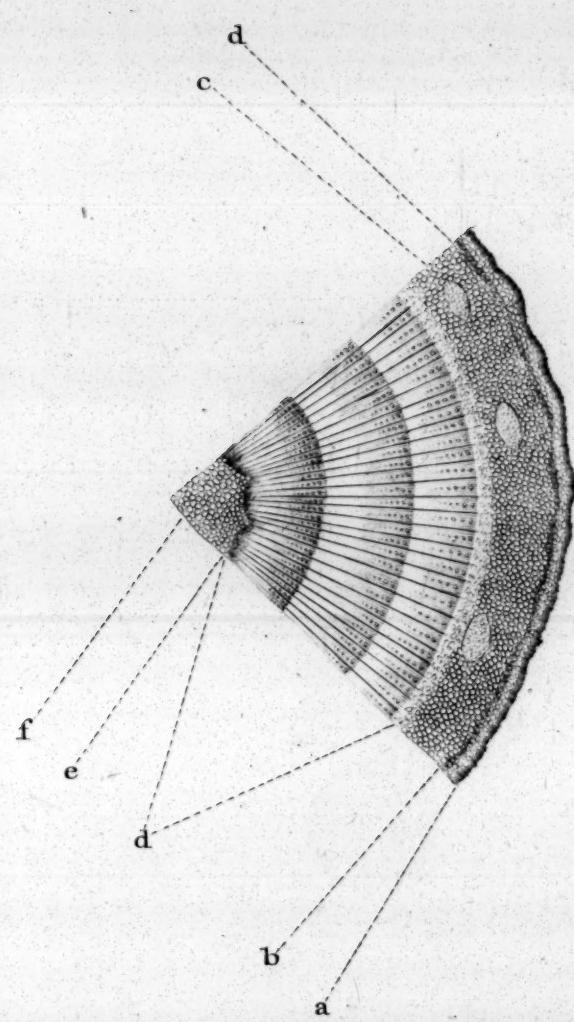
*AMERICAN CYPRESS*



37

Pl. 36

*LARIX*



## C H A P. II.

## Particularities in the VASA PROPRIA INTERIORA.

## I. Their single Distribution and small Number in the LARIX.

OF these important Vessels, (important in their use to man, tho' as it should seem less PLATE so than many other parts to the growth of the Tree,) we see a great variety, in XXXVI. number, disposition, and contents: but in all, whatever may be their difference of size, their structure is the same. To understand them best, the way is to see them where they are simplest and most distinct. The common Larch Tree is here selected for that purpose. In the section of it, Plate XXXVI. we see, in the great substance of its Bark, *b*, the mouths of a few Vessels; few, but very large, very conspicuously distinct, and serving in this light, to that most useful purpose, the clearing up a doubt, which some who have gone thro' these observations with me had entertained, till this object cleared them. The vastness of these Vessels had rendered them suspected not to be such, till I shewed turpentine exactly filling and ouzing up from them, on cutting in some kinds of Pine: and in others their situation without the centers of distinct cones of the Wood, confounded them in the imagination with those protrusions of the parietes which are, as has been shewn, the beginnings of encrease in that part. But here also the Larix afforded a distinct answer to the doubt. The Wood of this Tree, tho' extremely delicate, *d*, is not formed into large cones at all, but disposed between the several radii only: yet here appear these vast openings, *c*, as in other cases; and they are filled with a very singular kind of liquid mastick.

For the rest, the Larix affords a very pleasing and instructive view. The Rind is thicker than in most Trees; and close within its verge, between that and the Bark, are lodged the Vasa exteriora, *d*, in long and slender clusters, which at the last-mentioned season may distinguish themselves eminently by the juices they contain, they being of a high crimson. The Corona, *e*, is very beautiful in the Larix; and its Pith, *f*, is clear.

## II. Of their close Disposition in the TANACETUM FRUTICANS.

The number of these Vessels may be much greater, tho' in a single series, than we PLATE have seen them in the Larix. The Tanacetum Fruticans, a section of which is given XXXVII. at Plate XXXVII. is an instance of this disposition. In this singular Shrub, which so far approaches

## THE CONSTRUCTION OF TIMBER

PLATE approaches to the herbaceous kinds as to be almost all Pith, we see them in the substance XXXVII. of the Bark, at *b*, extremely large, and placed so near, that the circumference, instead of

*b* three or four in a quarter, here contains six or seven; the Plant having from twenty-four to twenty-eight in the circle of the Bark. In the resinous, and in some of the gummy Trees, we always find these Vessels filled with their proper juices. In this Shrub I have, *c* on the contrary, always found them empty, *c*: but near them, and behind them, are disposed other Vessels, *d*, large, tho' not like these, and close arranged in a regular connected line: these are at all times filled with a peculiar juice; tough, fragrant, firm, and coloured. Nature has not allotted the single series of Vasa interiora, as by an inviolable law belonging to all Plants; we shall see them, in a succeeding instance, in much greater quantity: and here, tho' it be less distinct or obvious, the case is just the same.

The farther particularities in the Tanacetum Fruticans are not a few or slight ones: *e* glands, *e*, in the form of hairs, hang on its outer Rind; a thing common in the herbaceous *f* tribe, tho' it be less so in Trees. The Blea, *f*, forms an undulated line, of a close *g* texture; and immediately within that stands what there is of Wood, *g*; a thin loose circle, formed not into cones, but oval bodies, and separated by the matter of the parietes, run *b* out into a kind of sponge, and forming a regular circle under the Blea. The Corona, *b*, is a circle of more than usual circumference; and Nature has allotted it accordingly to be *i* very thin: and the Pith, *i*, which is of the simplest kind, by far exceeds in quantity all the rest together.

### III. Of the various Series of the VASA PROPRIA INTERIORA in the PINUS CEMBRA.

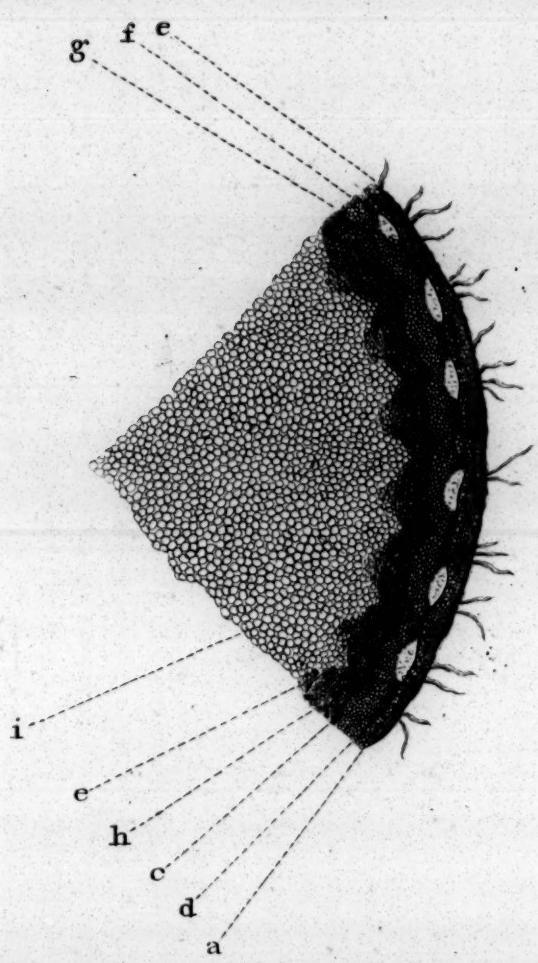
PLATE If the place of these supernumerary Vessels, in the preceding instance, could lead us to a XXXVIII. doubt whether they were or were not in reality of the nature of the Vasa exteriora; what

*a* was there conjecture here amounts to certainty. The Pinus Cembra, a section of which is given in Plate XXXVIII. beside its single range of immense Vasa exteriora, *a*, placed in the usual way in its thick Bark, has two or more less orderly ranges of Vessels, palpably of *b* the same nature: and even beside these there is a ring of smaller Vessels, *b*, surrounding, at a little distance, each of the larger. 'Tis happy that in this Tree the juice which fills the great Vasa propria is so pure and fine a turpentine, so abundant in its quantity, and so peculiar in its smell, that there could need no more or better test whether these other Vessels were of the same kind, than whether they did or did not carry the same peculiar juice. The tip of a pencil touched upon their open mouths determines this perfectly.

*c* What there is farther observable in this Tree, is, that the Rind, *c*, is thick, which indeed *d* is less unusual in the resinous Trees than those with watery juices; that the Bark, *d*, is very thick and very delicately formed, the cells being more distinct and yet with thinner *e f* edges than in most Trees: the Blea, *e*, is a firm, dusky, compact circle. The Wood, *f*, on the other hand, is transparent to a degree scarce seen in any other Tree, except those of its *g* own genus, and pierced with a considerable number of Sap-Vessels, *g*. In these, during the

Pl. 37

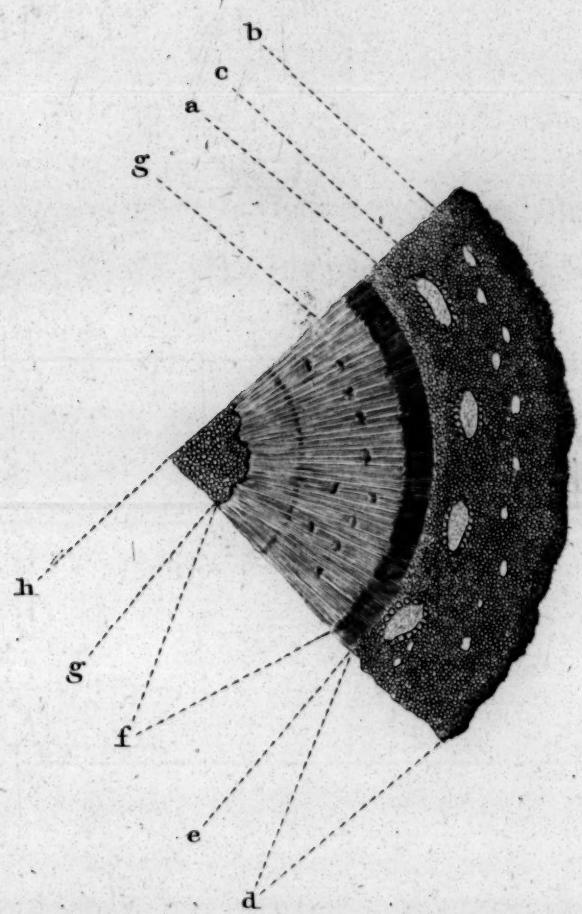
*TANACETUM FRUTICANS*





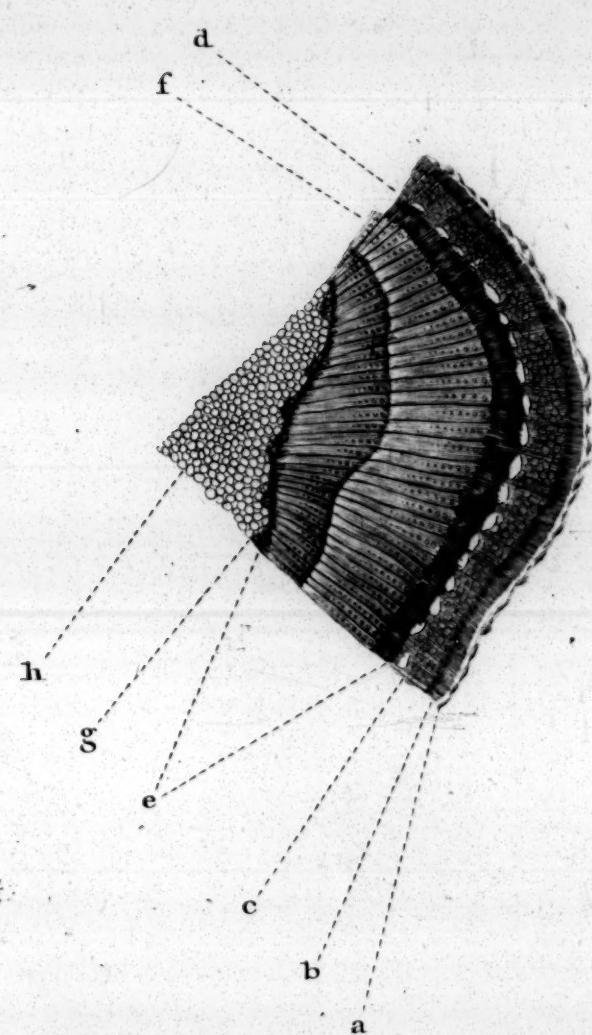
39  
Pl. 38

*PINUS CEMBRA*



*Pl. 39*

*HELIOTROPIUM ARBORESCENS*



the months of March and July, there is a watery subacid juice, a true Sap, untainted by the peculiar medicinal juices of the Tree; and at other times they are entirely empty: no turpentine being ever found in them, unless forced into their open mouths from some other part of the Tree. The Corona, *k*, is a thin but very distinct and elegant circle; and the Pith (which is not usual unless in resinous Trees) is coloured and clammy; and balsamic Vessels, containing a peculiar turpentine, a yellow kind, of a coarser sinell than the rest, rise thro' the Pith. These, in the cutting, shed a part of their contents, which spreads among the bladders of the Pith; and gives the whole that colour and that flavour.

## C H A P. III.

## Particularities in the VASA INTIMA of TREES.

## I. Their simplest State in the HELIOTROPIUM ARBORESCENS.

**A**S the Vasa intima of Plants have their proper place in the substance of the Blea, never PLATE being found in any part exterior to that, tho' sometimes farther within; we may judge that to be their plainest and simplest state where they are found in a single series in that part; and only there. Such an instance is the Tree Heliotrope, Plate XXXIX. This is one of those kinds which are warped to the sun, and in which all the inner coats conform themselves in shape to the exterior form of the Branch; and consequently form in their outline not circles, but irregular and waved ellipses. The Rind and Bark of the Heliotrope, *a b*, have nothing in them peculiar, unless it be that the Rind is more uneven than in many others. The Blea, *c*, is vast, and toward the inner part of it is placed a range of oval Vessels, *d*, filled with a thick, white, acrid juice, of the nature of what are called gum resins. Within these Vasa intima the Blea is more compact by far than near the Bark; and within this lies the Wood, *e*, beautifully pierced with round mouths of Sap-Vessels, which in July, when I last cut the Shrub, were so abundantly replete with a sourish water, that they floated all the section with it, and ran over every way at its edges. The Corona, *f*, here is a very delicate line, clear, except where the clusters of the Vessels are placed; and the Pith, *g*, is large and plain.

Q.

II. Their

## II. Their repeated Series in the PISCIDIA CARTHAGENENSIS.

**PLATE XL.** The finest view that it is possible to obtain of the Vasa intima of Trees, is that of the Piscidia Erythrina, given before, where the Vessels were examined as to their structure, in Plate XIII. but this other Piscidia, tho' much inferior to that, is not without its singularity or beauty. We have seen, in the Heliotrope, these Vessels lodged in their proper place, the Blea : Nature has there allotted to the Shrub a single line of them : here we have two, *a b*; and the second is in a place altogether singular, the Corona. The first and more natural series of these Vessels is ranged in the centre of the Blea : they are oval, large, and full of a juice, of a strong green, utterly unlike and distinct from all the other contents of the Branch. The repeated series occupies a considerable space in the plain Corona of the Tree, where they have also lost their oval form. They are perfectly cylindric, as is the most natural form of these vessels ; and one would be led to doubt their nature, were it not ascertained by their contents ; the same very green hard juice filling them.

What is farther observable in this species, is, the extreme number both of the Vasa exteriaria, *c*, and of Sap-Vessels, *d*. There are several uneven ranges of the first in the substance of the Bark ; and the latter occupy, with the same irregularity, a very great part of the Wood : yet is this Wood, *e*, pierced as it is like a cullender, not light, but very heavy. We should wonder at this, had not that familiar instance, the Oak, taught us that the strength and weight of Timber is not affected by these apertures.

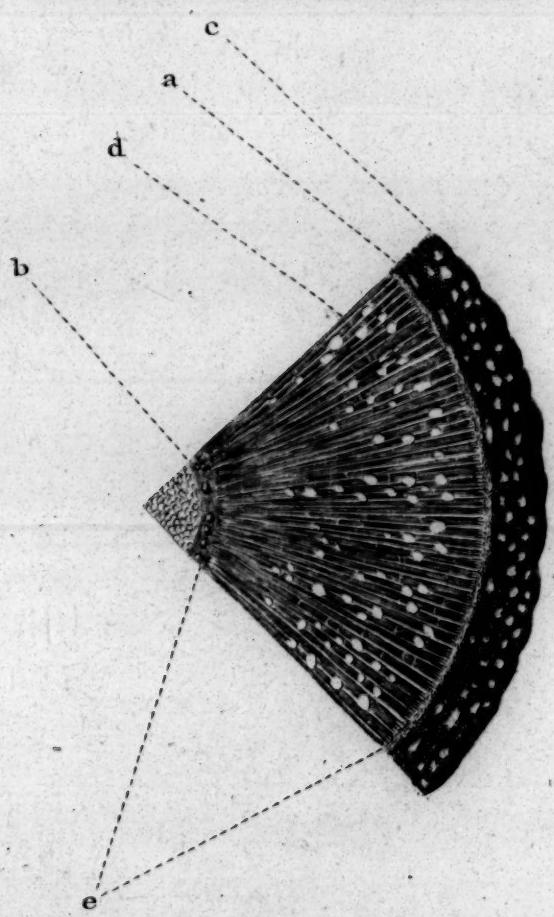
## III. The central Disposition of them in the HEMLOCK SPRUCE FIR.

**PLATE XLI.** We have seen the Vasa exteriaria enter the Pith, and stain it with their contents, in the Pinus Cembra : and howsoever it be out of the common course to see the Pith of Trees pervaded by longitudinal Vessels, yet the Fir, known by the name of Hemlock Spruce, will shew us that not the exteriaria alone, but the intima, can find their way thither. A section of this Tree is given, Plate XLI. The exterior range of these Vessels is formed, just where it should be, in the Blea, *a* : they are small, but distinguishable enough to an accustomed eye : they are perfectly round ; their coats have a remarkable thickness ; and they are stuffed full of a firm, red resin, not a little resembling what druggists call dragon's blood. In the Pith we meet with Vessels, *b*, round in their out-line, perfectly distinct in form from the cells of the Pith, and filled with this same red resin. It is impossible not to recognize the Vasa intima in these : they stain the whole of the Pith, in cutting, with this juice : but the slight colour that acquires by accident, is very easily to be distinguished from the deep and coarse contents of the Vessels themselves. While this section is before us, it is impossible but we must stop to admire the beautiful construction of the Wood, *c*, formed of lines drawn with a more than mechanical exactness, *d e f* and enclosing little cones, *d*, pierced with innumerable Sap-Vessels, *e*. The Corona, *f*, protuberates inward ; and, in a thin slice, is very distinct.

C H A P.

41  
Pl. 40

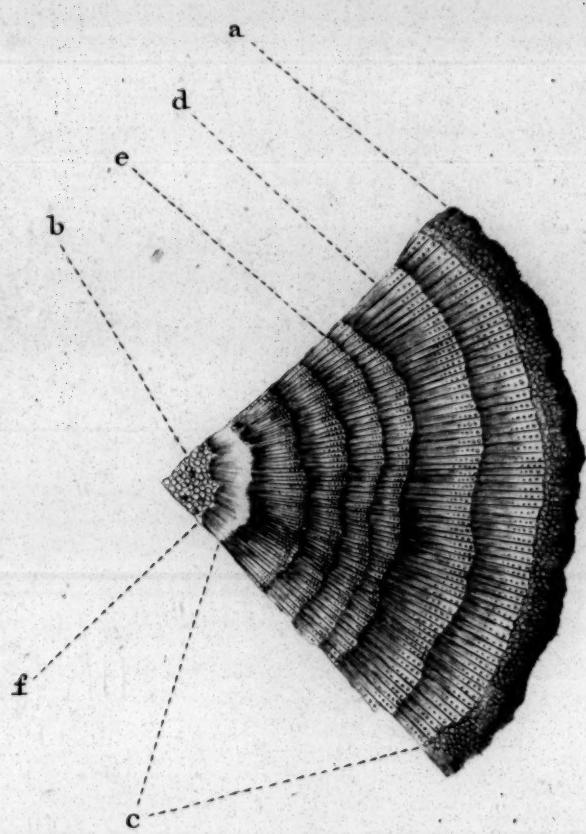
*PISCIDIA CARTHAGENENSIS*





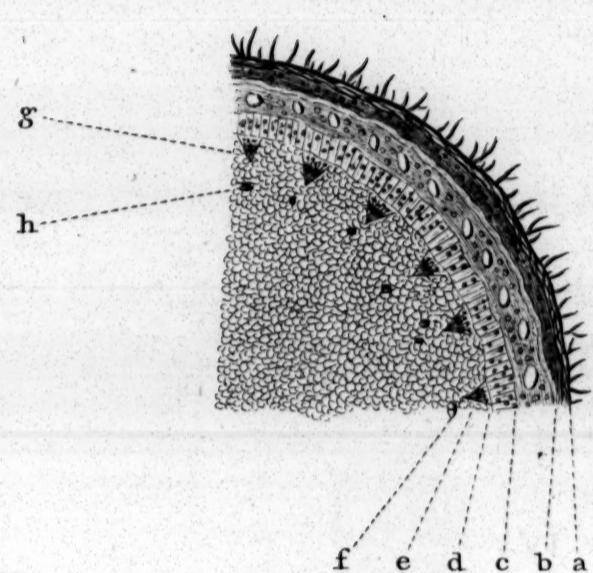
*Pl. 41*

*HEMLOCK SPRUCE FIR*



Pl. 42

SUMACH



## C H A P. IV.

## Particularities of the Coronal VESSELS:

## Their distinct Appearance in the SUMACH.

IT has been shewn that the Vessels of the Corona are no other than the several Vessels PLATE of the former kinds, only that they are here in a smaller compass, and of less size. XLII. They need not be described particularly after those; for greater and less is no distinction in philosophy: nor have these any other. Yet, as there is in Sumach an opportunity laid before the curious eye of being certified of this truth, it may be useful, as well as agreeable, to shew it. A section of this Tree is given, Plate XLII. where the first sight will shew how much it approaches to the herbaceous tribes in the glandular construction of its Rind, and in its vast Pith. Happily in this Tree the Corona makes a more distinct circle, more defined in itself, and more separate in its parts, than is to be seen elsewhere. When we have followed the construction of this Shoot from without, and seen its brown and hairy Rind, *a*, lined by the dark green juicy Bark, *b*, and within this the paler, yet green Blea, *c*, we distinguish very finely the ellipses of Wood, *d*; and within these the Corona. Its white circle, *e*, has let loose, as it were, the clusters, *f*; and one of these, separated, washed clean, and viewed by a greater power of glasses, appears as at Fig. 2. Fig. 2. where the Rind and Bark, thrown to the ends, 1. 2. shew dots at 3. which are here the 1. 2. 3. embryo Vasa exteriora; and larger specks at 4. the interiora. At 5. in that which is to be 4. 5. the Blea, are dots, tho' small, yet particular in colour; and 'tis impossible, both from that and from their place, to doubt their being Vasa intima in miniature. And in the central part, at 6. are Sap-Vessels, whose openings, as is the case in most other instances, are so big as almost to look preposterous. The Vasa exteriora, in the entire section, cannot but be admired; they are firm, full of a milky juice, and when the section, if of any thickness, has lain but a few minutes, they rise from its surface, being too solid to shrink with the rest. In the Pith, at a small distance, within the clusters of the Corona, *g*, are to be seen, very beautifully, purple Vessels, *h*, whose form and structure shews them Vasa intima.

## C H A P. V.

## Of the Distribution of the SAP-VESSELS, particularly in the OAKS.

**PLATE XLIII.** **T**O form a proper judgment of these Vessels, too much misunderstood by many, we can no where follow them better than in the Oak; the firmest, strongest, heaviest of Trees; yet pierced beyond all others by these Vessels. They have been shewn in their natural state in Plate III. in the common English Oak: and that size and distribution of them, however strange it might seem to an unaccustomed eye, is not peculiar to that single species. Nature is uniform in all her works; and tho' there be few Trees, if indeed any, that have these openings so large and numerous as the Scarlet and the English Oak, yet in all species of that Tree they are very nearly alike. In the Scarlet Oak of America, so pierced with them as to be unfit to contain, in vessels made of it, any thing but dry goods, they stand much as in our English kind, only not quite so regularly. **a b c** A view of this is given, Plate XLIII. There is a sort of triple row, **a b c**, formed of them in the Wood of each season, but not correctly. The Spanish Oak affords them in double rows. In the Ever-green Oak they have no circular direction, but run down obliquely cross-wise. In the Chestnut Oak they are thrown into rays. And in the Red Oak, not the Scarlet, cross-wise. But in all these species the proportion of aperture to solid is very nearly kept up, except in the Scarlet, where it is much greater than in any others. In the rest, where the Vessels are larger, there are fewest of them; and where smaller, their number makes amends for their want of size.

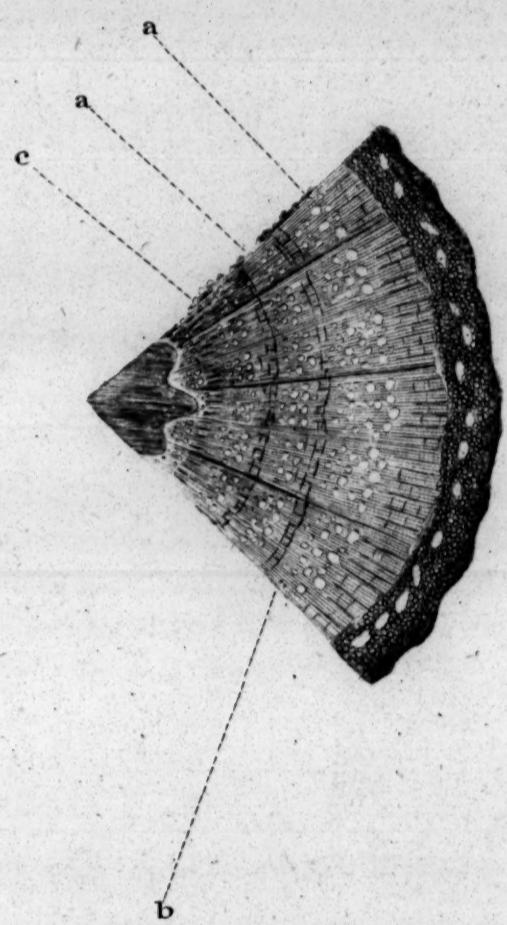


F I N I S.

I N D E X

*Pl. 43*

*SCARLET OAK*





# I N D E X.

A.	C A C I A	Page	E.	Page
		49	Engine Cutting	3
Alburnum	—	17	Ephedra	47
Almond	—	54	G.	
Annona	—	53	Growth	36
Arbutus	—	50	H.	
Ash Maple	—	39	Hemlock Fir	60
B.			Heliotropium Arborescens	59
Bark	—	16	L.	
Bark, its Uses	—	14	Larix	57
Bark of Willow	—	15	Liber	16
Bark of Ozier	—	15	Liriodendron	45
Bark, its Differences	—	43	M.	
Bark of the Service Tree	—	44	Magnolia	51
Blea	—	17	Microscope	5
Blea, its Particularities	—	45	N.	
Blea of the Liriodendron	—	45	Nerium Oleander	46
Blea of the Oleander	—	46	Nerium Zeylanicum	46
Blea of the Nerium Zeylanicum	—	46	O.	
Blea of Willow	—	18	Oak, English	8
Blea of Ozier	—	19	Oak, American	62
Blea of the Ephedra	—	47	Oak, Scarlet	62
Branches	—	36	Oak, Red	62
C.			Oak, Spanish	62
Circle of Propagation	—	21	Oak, Willow	62
Circles in Arbutus	—	50	Oak, Chestnut	62
Circles in Thuya Chinensis	—	50	Oak, Evergreen	62
Cistus Laurifolia	—	51	P.	
Clusters in Magnolia	—	51	Parts to obtain	10
Cornus	—	48	Petræa	54
Corona	—	21	Pinus Cembra	58
Corona, its Vessels	—	34	Piscidia Carthagagenensis	60
Corona, its Construction	—	23	Pith	24
Corona, its Parts	—	23	Pith, its Origin	25
Corona, its Vessels	—	23	Pith, its Nature	25
Corona, its Particularities	—	51	Pith, its Uses	26
Corona of the Cistus Laurifolia	—	51	Pith of the Annona	53
Corona of Magnolia	—	51	Pith of the Almond	54
Corona of Staphylæa	—	52	Pith of the Petracæa	54
Corona of Plucknetia	—	52	Plucknetia	52
Corona of the Oak	—	22		
Corona of the Bocconia	—	22		
Cortex	—	11		
Cortex, its Uses	—	12		
Cupressus Americana	—	56		
Cutting Engine	—	3		
D.				
Dog-Wood	—	48		
R.				
Quercus				

I	N	D	E	X.			
					Page		
<b>Q.</b>							
Quercus Anglia	—	—	8	Timber, its Parts	—	—	7
Quercus Americana	—	—	62	Trees, their Vessels	—	—	27
Quercus Sempervirens	—	—	62	Trees, their Growth	—	—	36—38
Quercus Castaneifolia	—	—	62				
Quercus Salicifolia	—	—	62				
Quercus Hispanica	—	—	62				
Quercus Rubra	—	—	62				
<b>R.</b>							
Rind	—	—	11	Vasa	—	—	27
Rind, its Differences	—	—	47	Vasa Propria Exteriora	—	—	27
Rind of Dog-Rose	—	—	42	Vasa Propria Interiora	—	—	29
Rind, its Uses	—	—	12	Vasa Propria Intima	—	—	31
Rind, its Construction	—	—	13	Vasa Succosa	—	—	33
Robinia	—	—	49	Vasa Exteriora in Cypress	—	—	56
Rosa Canina	—	—	42	Vasa Interiora in Larix	—	—	57
S.				Vasa Interiora in Tanacetum Fruticans	—	—	57
Sap-Vessels	—	—	31	Vasa Interiora in Pinus Cembra	—	—	58
Sap-Vessels, filling of them	—	—	34	Vasa Intima	—	—	59
Sap-Vessels in Oaks	—	—	62	Vasa Intima in Heliotrope	—	—	59
Seasons, Circles of	—	—	50	Vasa Intima in Piscidia Carthagrenensis	—	—	60
Shoots	—	—	38	Vasa Intima in Hemlock Fir	—	—	60
Shoot, its Growth	—	—	38	Vasa Coronalia	—	—	61
Staphylæa	—	—	52	Vasa Coronalia in Sumach	—	—	61
Sumach	—	—	61				
<b>T.</b>							
Tanacetum Fruticans	—	—	58	<b>W.</b>			
Thuya Chinensis	—	—	50	Wood	—	—	19
				Wood, its Construction	—	—	20
				Wood, its Vessels	—	—	20
				Wood of the Dog-Wood	—	—	48
				Wood of the Acacia	—	—	49
				Wood of the Robinia	—	—	49
				Wood of Pear-Tree	—	—	20
				Wood of Bauhinia	—	—	20

#### D I R E C T I O N S to the B I N D E R.

Plate		Page	Plate		Page	
I. to face	—	4	XXIII. to face	—	—	47
II. to face	—	6	XXIV. to face	—	—	48
III. to face	—	8	XXV. to face	—	—	49
IV. to face	—	12	XXVI. to face	—	—	49
V. to face	—	14	XXVII. to face	—	—	50
VI. to face	—	16	XXVIII. to face	—	—	50
VII. to face	—	18	XXIX. to face	—	—	51
VIII. to face	—	20	XXX. to face	—	—	51
IX. to face	—	22	XXXI. to face	—	—	52
X. to face	—	26	XXXII. to face	—	—	52
XI. to face	—	28	XXXIII. to face	—	—	53
XII. to face	—	29	XXXIV. to face	—	—	54
XIII. and XIII. repeated, to face	—	32	XXXV. to face	—	—	56
XIV. and XIV. repeated, to face	—	34	XXXVI. to face	—	—	57
XV. to face	—	35	XXXVII. to face	—	—	58
XVI. to face	—	38	XXXVIII. to face	—	—	58
XVII. to face	—	40	XXXIX. to face	—	—	59
XVIII. to face	—	42	XL. to face	—	—	60
XIX. to face	—	44	XLI. to face	—	—	60
XX. to face	—	45	XLII. to face	—	—	61
XXI. to face	—	46	XLIII. to face	—	—	62
XXII. to face	—	46				



(2)

